(old) htmldiff from- (new)

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(old) htmldiff from- (new)

(old) htmldiff from- (new)

A64 -- Base Instructions (alphabetic order)

ADC: Add with Carry.

ADCS: Add with Carry, setting flags.

ADD (extended register): Add (extended register).

ADD (immediate): Add (immediate).

ADD (shifted register): Add (shifted register).

ADDG: Add with Tag.

ADDS (extended register): Add (extended register), setting flags.

ADDS (immediate): Add (immediate), setting flags.

ADDS (shifted register): Add (shifted register), setting flags.

ADR: Form PC-relative address.

ADRP: Form PC-relative address to 4KB page.

AND (immediate): Bitwise AND (immediate).

AND (shifted register): Bitwise AND (shifted register).

ANDS (immediate): Bitwise AND (immediate), setting flags.

ANDS (shifted register): Bitwise AND (shifted register), setting flags.

ASR (immediate): Arithmetic Shift Right (immediate): an alias of SBFM.

ASR (register): Arithmetic Shift Right (register): an alias of ASRV.

ASRV: Arithmetic Shift Right Variable.

AT: Address Translate: an alias of SYS.

AUTDA, AUTDZA: Authenticate Data address, using key A.

AUTDB, AUTDZB: Authenticate Data address, using key B.

AUTIA, AUTIA1716, AUTIASP, AUTIAZ, AUTIZA: Authenticate Instruction address, using key A.

AUTIB, AUTIB1716, AUTIBSP, AUTIBZ, AUTIZB: Authenticate Instruction address, using key B.

AXFLAG~~AXFlag~~: Convert floating-point condition flags from Arm to external format.

B: Branch.

B.cond: Branch conditionally.

BFC: Bitfield Clear: an alias of BFM.

BFI: Bitfield Insert: an alias of BFM.

BFM: Bitfield Move.

BFXIL: Bitfield extract and insert at low end: an alias of BFM.

BIC (shifted register): Bitwise Bit Clear (shifted register).

BICS (shifted register): Bitwise Bit Clear (shifted register), setting flags.

BL: Branch with Link.

BLR: Branch with Link to Register.

BLRAA, BLRAAZ, BLRAB, BLRABZ: Branch with Link to Register, with pointer authentication.

BR: Branch to Register.

BRAA, BRAAZ, BRAB, BRABZ: Branch to Register, with pointer authentication.

BRK: Breakpoint instruction.

BTI: Branch Target Identification.

CAS, CASA, CASAL, CASL: Compare and Swap word or doubleword in memory.

CASB, CASAB, CASALB, CASLB: Compare and Swap byte in memory.

CASH, CASAH, CASALH, CASLH: Compare and Swap halfword in memory.

CASP, CASPA, CASPAL, CASPL: Compare and Swap Pair of words or doublewords in memory.

CBNZ: Compare and Branch on Nonzero.

CBZ: Compare and Branch on Zero.

CCMN (immediate): Conditional Compare Negative (immediate).

CCMN (register): Conditional Compare Negative (register).

CCMP (immediate): Conditional Compare (immediate).

CCMP (register): Conditional Compare (register).

CFINV: Invert Carry Flag.

CFP: Control Flow Prediction Restriction by Context: an alias of SYS.

CINC: Conditional Increment: an alias of CSINC.

CINV: Conditional Invert: an alias of CSINV.

CLREX: Clear Exclusive.

CLS: Count Leading Sign bits.

CLZ: Count Leading Zeros.

CMN (extended register): Compare Negative (extended register): an alias of ADDS (extended register).

CMN (immediate): Compare Negative (immediate): an alias of ADDS (immediate).

CMN (shifted register): Compare Negative (shifted register): an alias of ADDS (shifted register).

CMP (extended register): Compare (extended register): an alias of SUBS (extended register).

CMP (immediate): Compare (immediate): an alias of SUBS (immediate).

CMP (shifted register): Compare (shifted register): an alias of SUBS (shifted register).

CMPP: Compare with Tag: an alias of SUBPS.

CNEG: Conditional Negate: an alias of CSNEG.

CPP: Cache Prefetch Prediction Restriction by Context: an alias of SYS.

CRC32B, CRC32H, CRC32W, CRC32X: CRC32 checksum.

CRC32CB, CRC32CH, CRC32CW, CRC32CX: CRC32C checksum.

CSDB: Consumption of Speculative Data Barrier.

CSEL: Conditional Select.

CSET: Conditional Set: an alias of CSINC.

CSETM: Conditional Set Mask: an alias of CSINV.

CSINC: Conditional Select Increment.

CSINV: Conditional Select Invert.

CSNEG: Conditional Select Negation.

DC: Data Cache operation: an alias of SYS.

DCPS1: Debug Change PE State to EL1..

DCPS2: Debug Change PE State to EL2..

DCPS3: Debug Change PE State to EL3.

DMB: Data Memory Barrier.

DRPS: Debug restore process state.

DSB: Data Synchronization Barrier.

DVP: Data Value Prediction Restriction by Context: an alias of SYS.

EON (shifted register): Bitwise Exclusive OR NOT (shifted register).

EOR (immediate): Bitwise Exclusive OR (immediate).

EOR (shifted register): Bitwise Exclusive OR (shifted register).

ERET: Exception Return.

ERETAA, ERETAB: Exception Return, with pointer authentication.

ESB: Error Synchronization Barrier.

EXTR: Extract register.

GMI: Tag Mask Insert.

HINT: Hint instruction.

HLT: Halt instruction.

HVC: Hypervisor Call.

IC: Instruction Cache operation: an alias of SYS.

IRG: Insert Random Tag.

ISB: Instruction Synchronization Barrier.

LDADD, LDADDA, LDADDAL, LDADDL: Atomic add on word or doubleword in memory.

LDADDB, LDADDAB, LDADDALB, LDADDLB: Atomic add on byte in memory.

LDADDH, LDADDAH, LDADDALH, LDADDLH: Atomic add on halfword in memory.

LDAPR: Load-Acquire RCpc Register.

LDAPRB: Load-Acquire RCpc Register Byte.

LDAPRH: Load-Acquire RCpc Register Halfword.

LDAPUR: Load-Acquire RCpc Register (unscaled).

LDAPURB: Load-Acquire RCpc Register Byte (unscaled).

LDAPURH: Load-Acquire RCpc Register Halfword (unscaled).

LDAPURSB: Load-Acquire RCpc Register Signed Byte (unscaled).

LDAPURSH: Load-Acquire RCpc Register Signed Halfword (unscaled).

LDAPURSW: Load-Acquire RCpc Register Signed Word (unscaled).

LDAR: Load-Acquire Register.

LDARB: Load-Acquire Register Byte.

LDARH: Load-Acquire Register Halfword.

LDAXP: Load-Acquire Exclusive Pair of Registers.

LDAXR: Load-Acquire Exclusive Register.

LDAXRB: Load-Acquire Exclusive Register Byte.

LDAXRH: Load-Acquire Exclusive Register Halfword.

LDCLR, LDCLRA, LDCLRAL, LDCLRL: Atomic bit clear on word or doubleword in memory.

LDCLRB, LDCLRAB, LDCLRALB, LDCLRLB: Atomic bit clear on byte in memory.

LDCLRH, LDCLRAH, LDCLRALH, LDCLRLH: Atomic bit clear on halfword in memory.

LDEOR, LDEORA, LDEORAL, LDEORL: Atomic exclusive OR on word or doubleword in memory.

LDEORB, LDEORAB, LDEORALB, LDEORLB: Atomic exclusive OR on byte in memory.

LDEORH, LDEORAH, LDEORALH, LDEORLH: Atomic exclusive OR on halfword in memory.

LDG: Load Allocation Tag.

LDGM: Load Tag Multiple.

LDLAR: Load LOAcquire Register.

LDLARB: Load LOAcquire Register Byte.

LDLARH: Load LOAcquire Register Halfword.

LDNP: Load Pair of Registers, with non-temporal hint.

LDP: Load Pair of Registers.

LDPSW: Load Pair of Registers Signed Word.

LDR (immediate): Load Register (immediate).

LDR (literal): Load Register (literal).

LDR (register): Load Register (register).

LDRAA, LDRAB: Load Register, with pointer authentication.

LDRB (immediate): Load Register Byte (immediate).

LDRB (register): Load Register Byte (register).

LDRH (immediate): Load Register Halfword (immediate).

LDRH (register): Load Register Halfword (register).

LDRSB (immediate): Load Register Signed Byte (immediate).

LDRSB (register): Load Register Signed Byte (register).

LDRSH (immediate): Load Register Signed Halfword (immediate).

LDRSH (register): Load Register Signed Halfword (register).

LDRSW (immediate): Load Register Signed Word (immediate).

LDRSW (literal): Load Register Signed Word (literal).

LDRSW (register): Load Register Signed Word (register).

LDSET, LDSETA, LDSETAL, LDSETL: Atomic bit set on word or doubleword in memory.

LDSETB, LDSETAB, LDSETALB, LDSETLB: Atomic bit set on byte in memory.

LDSETH, LDSETAH, LDSETALH, LDSETLH: Atomic bit set on halfword in memory.

LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL: Atomic signed maximum on word or doubleword in memory.

LDSMAXB, LDSMAXAB, LDSMAXALB, LDSMAXLB: Atomic signed maximum on byte in memory.

LDSMAXH, LDSMAXAH, LDSMAXALH, LDSMAXLH: Atomic signed maximum on halfword in memory.

LDSMIN, LDSMINA, LDSMINAL, LDSMINL: Atomic signed minimum on word or doubleword in memory.

LDSMINB, LDSMINAB, LDSMINALB, LDSMINLB: Atomic signed minimum on byte in memory.

LDSMINH, LDSMINAH, LDSMINALH, LDSMINLH: Atomic signed minimum on halfword in memory.

LDTR: Load Register (unprivileged).

LDTRB: Load Register Byte (unprivileged).

LDTRH: Load Register Halfword (unprivileged).

LDTRSB: Load Register Signed Byte (unprivileged).

LDTRSH: Load Register Signed Halfword (unprivileged).

LDTRSW: Load Register Signed Word (unprivileged).

LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL: Atomic unsigned maximum on word or doubleword in memory.

LDUMAXB, LDUMAXAB, LDUMAXALB, LDUMAXLB: Atomic unsigned maximum on byte in memory.

LDUMAXH, LDUMAXAH, LDUMAXALH, LDUMAXLH: Atomic unsigned maximum on halfword in memory.

LDUMIN, LDUMINA, LDUMINAL, LDUMINL: Atomic unsigned minimum on word or doubleword in memory.

LDUMINB, LDUMINAB, LDUMINALB, LDUMINLB: Atomic unsigned minimum on byte in memory.

LDUMINH, LDUMINAH, LDUMINALH, LDUMINLH: Atomic unsigned minimum on halfword in memory.

LDUR: Load Register (unscaled).

LDURB: Load Register Byte (unscaled).

LDURH: Load Register Halfword (unscaled).

LDURSB: Load Register Signed Byte (unscaled).

LDURSH: Load Register Signed Halfword (unscaled).

LDURSW: Load Register Signed Word (unscaled).

LDXP: Load Exclusive Pair of Registers.

LDXR: Load Exclusive Register.

LDXRB: Load Exclusive Register Byte.

LDXRH: Load Exclusive Register Halfword.

LSL (immediate): Logical Shift Left (immediate): an alias of UBFM.

LSL (register): Logical Shift Left (register): an alias of LSLV.

LSLV: Logical Shift Left Variable.

LSR (immediate): Logical Shift Right (immediate): an alias of UBFM.

LSR (register): Logical Shift Right (register): an alias of LSRV.

LSRV: Logical Shift Right Variable.

MADD: Multiply-Add.

MNEG: Multiply-Negate: an alias of MSUB.

MOV (bitmask immediate): Move (bitmask immediate): an alias of ORR (immediate).

MOV (inverted wide immediate): Move (inverted wide immediate): an alias of MOVN.

MOV (register): Move (register): an alias of ORR (shifted register).

MOV (to/from SP): Move between register and stack pointer: an alias of ADD (immediate).

MOV (wide immediate): Move (wide immediate): an alias of MOVZ.

MOVK: Move wide with keep.

MOVN: Move wide with NOT.

MOVZ: Move wide with zero.

MRS: Move System Register.

MSR (immediate): Move immediate value to Special Register.

MSR (register): Move general-purpose register to System Register.

MSUB: Multiply-Subtract.

MUL: Multiply: an alias of MADD.

MVN: Bitwise NOT: an alias of ORN (shifted register).

NEG (shifted register): Negate (shifted register): an alias of SUB (shifted register).

NEGS: Negate, setting flags: an alias of SUBS (shifted register).

NGC: Negate with Carry: an alias of SBC.

NGCS: Negate with Carry, setting flags: an alias of SBCS.

NOP: No Operation.

ORN (shifted register): Bitwise OR NOT (shifted register).

ORR (immediate): Bitwise OR (immediate).

ORR (shifted register): Bitwise OR (shifted register).

PACDA, PACDZA: Pointer Authentication Code for Data address, using key A.

PACDB, PACDZB: Pointer Authentication Code for Data address, using key B.

PACGA: Pointer Authentication Code, using Generic key.

PACIA, PACIA1716, PACIASP, PACIAZ, PACIZA: Pointer Authentication Code for Instruction address, using key A.

PACIB, PACIB1716, PACIBSP, PACIBZ, PACIZB: Pointer Authentication Code for Instruction address, using key B.

PRFM (immediate): Prefetch Memory (immediate).

PRFM (literal): Prefetch Memory (literal).

PRFM (register): Prefetch Memory (register).

PRFUM: Prefetch Memory (unscaled offset).

PSB CSYNC: Profiling Synchronization Barrier.

PSSBB: Physical Speculative Store Bypass Barrier.

RBIT: Reverse Bits.

RET: Return from subroutine.

RETAA, RETAB: Return from subroutine, with pointer authentication.

REV: Reverse Bytes.

REV16: Reverse bytes in 16-bit halfwords.

REV32: Reverse bytes in 32-bit words.

REV64: Reverse Bytes: an alias of REV.

RMIF: Rotate, Mask Insert Flags.

ROR (immediate): Rotate right (immediate): an alias of EXTR.

ROR (register): Rotate Right (register): an alias of RORV.

RORV: Rotate Right Variable.

SB: Speculation Barrier.

SBC: Subtract with Carry.

SBCS: Subtract with Carry, setting flags.

SBFIZ: Signed Bitfield Insert in Zero: an alias of SBFM.

SBFM: Signed Bitfield Move.

SBFX: Signed Bitfield Extract: an alias of SBFM.

SDIV: Signed Divide.

SETF8, SETF16: Evaluation of 8 or 16 bit flag values.

SEV: Send Event.

SEVL: Send Event Local.

SMADDL: Signed Multiply-Add Long.

SMC: Secure Monitor Call.

SMNEGL: Signed Multiply-Negate Long: an alias of SMSUBL.

SMSUBL: Signed Multiply-Subtract Long.

SMULH: Signed Multiply High.

SMULL: Signed Multiply Long: an alias of SMADDL.

SSBB: Speculative Store Bypass Barrier.

ST2G: Store Allocation Tags.

STADD, STADDL: Atomic add on word or doubleword in memory, without return: an alias of LDADD, LDADDA, LDADDAL, LDADDL.

STADDB, STADDLB: Atomic add on byte in memory, without return: an alias of LDADDB, LDADDAB, LDADDALB, LDADDLB.

STADDH, STADDLH: Atomic add on halfword in memory, without return: an alias of LDADDH, LDADDAH, LDADDALH, LDADDLH.

STCLR, STCLRL: Atomic bit clear on word or doubleword in memory, without return: an alias of LDCLR, LDCLRA, LDCLRAL, LDCLRL.

STCLRB, STCLRLB: Atomic bit clear on byte in memory, without return: an alias of LDCLRB, LDCLRAB, LDCLRALB, LDCLRLB.

STCLRH, STCLRLH: Atomic bit clear on halfword in memory, without return: an alias of LDCLRH, LDCLRAH, LDCLRALH, LDCLRLH.

STEOR, STEORL: Atomic exclusive OR on word or doubleword in memory, without return: an alias of LDEOR, LDEORA, LDEORAL, LDEORL.

STEORB, STEORLB: Atomic exclusive OR on byte in memory, without return: an alias of LDEORB, LDEORAB, LDEORALB, LDEORLB.

STEORH, STEORLH: Atomic exclusive OR on halfword in memory, without return: an alias of LDEORH, LDEORAH, LDEORALH, LDEORLH.

STG: Store Allocation Tag.

STGM: Store Tag Multiple.

STGP: Store Allocation Tag and Pair of registers.

STLLR: Store LORelease Register.

STLLRB: Store LORelease Register Byte.

STLLRH: Store LORelease Register Halfword.

STLR: Store-Release Register.

STLRB: Store-Release Register Byte.

STLRH: Store-Release Register Halfword.

STLUR: Store-Release Register (unscaled).

STLURB: Store-Release Register Byte (unscaled).

STLURH: Store-Release Register Halfword (unscaled).

STLXP: Store-Release Exclusive Pair of registers.

STLXR: Store-Release Exclusive Register.

STLXRB: Store-Release Exclusive Register Byte.

STLXRH: Store-Release Exclusive Register Halfword.

STNP: Store Pair of Registers, with non-temporal hint.

STP: Store Pair of Registers.

STR (immediate): Store Register (immediate).

STR (register): Store Register (register).

STRB (immediate): Store Register Byte (immediate).

STRB (register): Store Register Byte (register).

STRH (immediate): Store Register Halfword (immediate).

STRH (register): Store Register Halfword (register).

STSET, STSETL: Atomic bit set on word or doubleword in memory, without return: an alias of LDSET, LDSETA, LDSETAL, LDSETL.

STSETB, STSETLB: Atomic bit set on byte in memory, without return: an alias of LDSETB, LDSETAB, LDSETALB, LDSETLB.

STSETH, STSETLH: Atomic bit set on halfword in memory, without return: an alias of LDSETH, LDSETAH, LDSETALH, LDSETLH.

STSMAX, STSMAXL: Atomic signed maximum on word or doubleword in memory, without return: an alias of LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL.

STSMAXB, STSMAXLB: Atomic signed maximum on byte in memory, without return: an alias of LDSMAXB, LDSMAXAB, LDSMAXALB, LDSMAXLB.

STSMAXH, STSMAXLH: Atomic signed maximum on halfword in memory, without return: an alias of LDSMAXH, LDSMAXAH, LDSMAXALH, LDSMAXLH.

STSMIN, STSMINL: Atomic signed minimum on word or doubleword in memory, without return: an alias of LDSMIN, LDSMINA, LDSMINAL, LDSMINL.

STSMINB, STSMINLB: Atomic signed minimum on byte in memory, without return: an alias of LDSMINB, LDSMINAB, LDSMINALB, LDSMINLB.

STSMINH, STSMINLH: Atomic signed minimum on halfword in memory, without return: an alias of LDSMINH, LDSMINAH, LDSMINALH, LDSMINLH.

STTR: Store Register (unprivileged).

STTRB: Store Register Byte (unprivileged).

STTRH: Store Register Halfword (unprivileged).

STUMAX, STUMAXL: Atomic unsigned maximum on word or doubleword in memory, without return: an alias of LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL.

STUMAXB, STUMAXLB: Atomic unsigned maximum on byte in memory, without return: an alias of LDUMAXB, LDUMAXAB, LDUMAXALB, LDUMAXLB.

STUMAXH, STUMAXLH: Atomic unsigned maximum on halfword in memory, without return: an alias of LDUMAXH, LDUMAXAH, LDUMAXALH, LDUMAXLH.

STUMIN, STUMINL: Atomic unsigned minimum on word or doubleword in memory, without return: an alias of LDUMIN, LDUMINA, LDUMINAL, LDUMINL.

STUMINB, STUMINLB: Atomic unsigned minimum on byte in memory, without return: an alias of LDUMINB, LDUMINAB, LDUMINALB, LDUMINLB.

STUMINH, STUMINLH: Atomic unsigned minimum on halfword in memory, without return: an alias of LDUMINH, LDUMINAH, LDUMINALH, LDUMINLH.

STUR: Store Register (unscaled).

STURB: Store Register Byte (unscaled).

STURH: Store Register Halfword (unscaled).

STXP: Store Exclusive Pair of registers.

STXR: Store Exclusive Register.

STXRB: Store Exclusive Register Byte.

STXRH: Store Exclusive Register Halfword.

STZ2G: Store Allocation Tags, Zeroing.

STZG: Store Allocation Tag, Zeroing.

STZGM: Store Tag and Zero Multiple.

SUB (extended register): Subtract (extended register).

SUB (immediate): Subtract (immediate).

SUB (shifted register): Subtract (shifted register).

SUBG: Subtract with Tag.

SUBP: Subtract Pointer.

SUBPS: Subtract Pointer, setting Flags.

SUBS (extended register): Subtract (extended register), setting flags.

SUBS (immediate): Subtract (immediate), setting flags.

SUBS (shifted register): Subtract (shifted register), setting flags.

SVC: Supervisor Call.

SWP, SWPA, SWPAL, SWPL: Swap word or doubleword in memory.

SWPB, SWPAB, SWPALB, SWPLB: Swap byte in memory.

SWPH, SWPAH, SWPALH, SWPLH: Swap halfword in memory.

SXTB: Signed Extend Byte: an alias of SBFM.

SXTH: Sign Extend Halfword: an alias of SBFM.

SXTW: Sign Extend Word: an alias of SBFM.

SYS: System instruction.

SYSL: System instruction with result.

TBL: Programmable table lookup in one or two vector table (zeroing).

TBNZ: Test bit and Branch if Nonzero.

TBZ: Test bit and Branch if Zero.

TCANCEL: Cancel current transaction.

TCOMMIT: Commit current transaction.

TLBI: TLB Invalidate operation: an alias of SYS.

TSB CSYNC: Trace Synchronization Barrier.

TST (immediate): Test bits (immediate): an alias of ANDS (immediate).

TST (shifted register): Test (shifted register): an alias of ANDS (shifted register).

TSTART: Start transaction.

TTEST: Test transaction state.

UBFIZ: Unsigned Bitfield Insert in Zero: an alias of UBFM.

UBFM: Unsigned Bitfield Move.

UBFX: Unsigned Bitfield Extract: an alias of UBFM.

UDF: Permanently Undefined.

UDIV: Unsigned Divide.

UMADDL: Unsigned Multiply-Add Long.

UMNEGL: Unsigned Multiply-Negate Long: an alias of UMSUBL.

UMSUBL: Unsigned Multiply-Subtract Long.

UMULH: Unsigned Multiply High.

UMULL: Unsigned Multiply Long: an alias of UMADDL.

UXTB: Unsigned Extend Byte: an alias of UBFM.

UXTH: Unsigned Extend Halfword: an alias of UBFM.

WFE: Wait For Event.

WFI: Wait For Interrupt.

XAFLAG~~XAFlag~~: Convert floating-point condition flags from external format to Arm format.

XPACD, XPACI, XPACLRI: Strip Pointer Authentication Code.

YIELD: YIELD.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

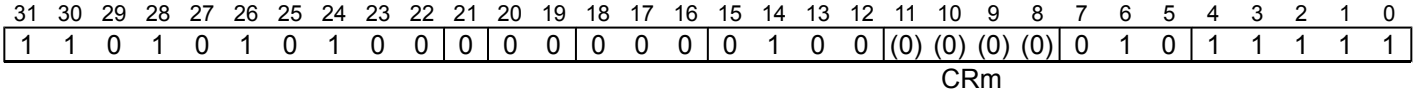
(old) htmldiff from- (new)

AXFLAGAXFlag

Convert floating-point condition flags from Arm to external format. This instruction converts the state of the PSTATE.{N,Z,C,V} flags from a form representing the result of an Arm floating-point scalar compare instruction to an alternative representation required by some software.

System

(Armv8.5)



System

AXFLAGAXFlag

```
if !HaveFlagFormatExt() then UNDEFINED;
```

Operation

```
bit N = '0';
bit Z = PSTATE.Z OR PSTATE.V;
bit C = PSTATE.C AND NOT(PSTATE.V);
bit V = '0';

PSTATE.N = N;
PSTATE.Z = Z;
PSTATE.C = C;
PSTATE.V = V;
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

BTI

Branch Target Identification. A BTI instruction is used to guard against the execution of instructions which are not the intended target of a branch.

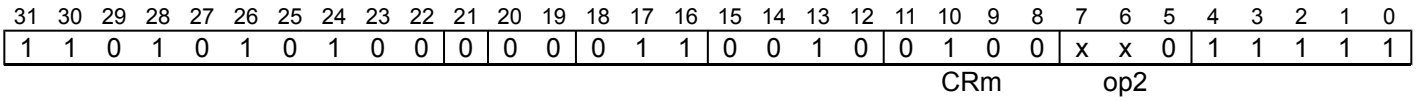
Outside of a guarded memory region, a BTI instruction executes as a NOP. Within a guarded memory region while *PSTATE*.BTYPE != 0b00, a BTI instruction compatible with the current value of PSTATE.BTYPE will not generate a Branch Target Exception and will allow execution of subsequent instructions within the memory region.

The operand <targets> passed to a BTI instruction determines the values of *PSTATE*.BTYPE which the BTI instruction is compatible with.

Within a guarded memory region, while *PSTATE*.BTYPE
!= 0b00, all instructions will generate a Branch Target
Exception, other than BRK, BTI, HLT, PACIASP,
and PACIBSP, which may not. See the individual instructions for details.

System

(Armv8.5)



System

```
BTI {<targets>}
```

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Assembler Symbols

<targets> Is the type of indirection, encoded in “op2<2:1>”:

op2<2:1>	<targets>
00	(omitted)
01	c
10	j
11	jc

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

(old) htmldiff from- (new)

CSDB

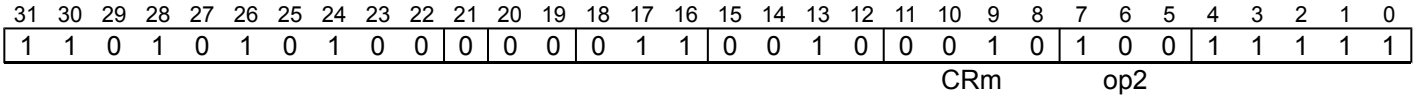
Consumption of Speculative Data Barrier is a memory barrier that controls speculative execution and data value prediction.

No instruction other than branch instructions appearing in program order after the CSDB can be speculatively executed using the results of any:

- Data value predictions of any instructions.
- PSTATE.{N,Z,C,V} predictions of any instructions other than conditional branch instructions appearing in program order before the CSDB that have not been architecturally resolved.
- Predictions of SVE predication state for any SVE instructions.

For purposes of the definition of CSDB, PSTATE.{N,Z,C,V} is not considered a data value. This definition permits:

- Control flow speculation before and after the CSDB.
- Speculative execution of conditional data processing instructions after the CSDB, unless they use the results of data value or PSTATE.{N,Z,C,V} predictions of instructions appearing in program order before the CSDB that have not been architecturally resolved.



System

CSDB

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

ESB

Error Synchronization Barrier is an error synchronization event that might also update DISR_EL1 and VDISR_EL2.

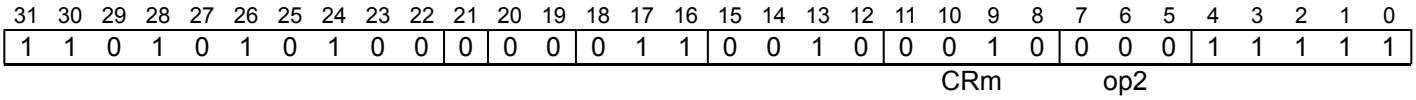
This instruction can be used at all Exception levels and in Debug state.

In Debug state, this instruction behaves as if SError interrupts are masked at all Exception levels. See Error Synchronization Barrier in the Arm(R) Reliability, Availability, and Serviceability (RAS) Specification, Armv8, for Armv8-A architecture profile.

If the RAS Extension is not implemented, this instruction executes as a NOP.

System

(Armv8.2)



System

```
ESB
```

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

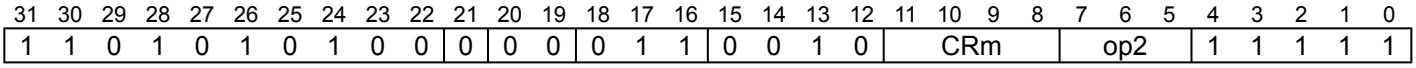
```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

HINT

Hint instruction is for the instruction set space that is reserved for architectural hint instructions.

Some encodings described here are not allocated in this revision of the architecture, and behave as NOPs. These encodings might be allocated to other hint functionality in future revisions of the architecture and therefore must not be used by software.



System

```
HINT #<imm>
```

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Assembler Symbols

<imm> Is a 7-bit unsigned immediate, in the range 0 to 127 encoded in the "CRm:op2" field.

The encodings that are allocated to architectural hint functionality are described in the "Hints" table in the "Index by Encoding".

For allocated encodings of "CRm:op2":

- A disassembler will disassemble the allocated instruction, rather than the `HINT` instruction.
- An assembler may support assembly of allocated encodings using `HINT` with the corresponding <imm> value, but it is not required to do so.

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

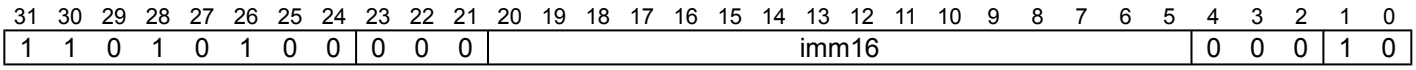
HVC

Hypervisor Call causes an exception to EL2. Non-secure software executing at EL1 can use this instruction to call the hypervisor to request a service.

The HVC instruction is UNDEFINED:

- At EL0.~~EL0, and Secure EL1~~.
- At EL1 if EL2 is not enabled in the current Security state.
- When *SCR_EL3*.HCE is set to 0.

On executing an HVC instruction, the PE records the exception as a Hypervisor Call exception in *ESR_ELx*, using the EC value 0x16, and the value of the immediate argument.



System

```
HVC #<imm>

bits(16) imm = imm16;
```

Assembler Symbols

<imm>	Is a 16-bit unsigned immediate, in the range 0 to 65535, encoded in the "imm16" field.

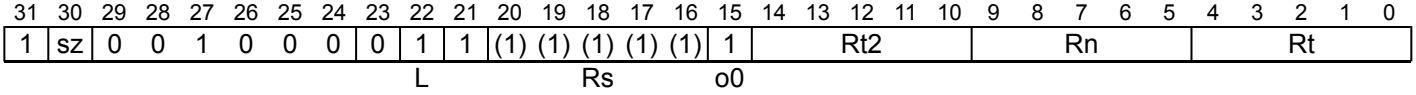
Operation

```
if !HaveEL(EL2) || PSTATE.EL == EL0 || (PSTATE.EL == EL1 && (!IsSecureEL2Enabled() && IsSecure())) then
    UNDEFINED;

hvc_enable = if HaveEL(EL3) then SCR_EL3.HCE else NOT(HCR_EL2.HCD);
if hvc_enable == '0' then
    AArch64.UndefinedFault();
else
    AArch64.CallHypervisor(imm);
```

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LDAXP

Load-Acquire Exclusive Pair of Registers derives an address from a base register value, loads two 32-bit words or two 64-bit doublewords from memory, and writes them to two registers. A 32-bit pair requires the address to be doubleword aligned and is single-copy atomic at doubleword granularity. A 64-bit pair requires the address to be quadword aligned and is single-copy atomic for each doubleword at doubleword granularity. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (sz == 0)

```
LDAXP <Wt1>, <Wt2>, [<Xn|SP>{,#0}]
```

64-bit (sz == 1)

```
LDAXP <Xt1>, <Xt2>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = TRUE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 32 << UInt(sz);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *LDAXP*.

Assembler Symbols

<Wt1>	Is the 32-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.
<Wt2>	Is the 32-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.
<Xt1>	Is the 64-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.
<Xt2>	Is the 64-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

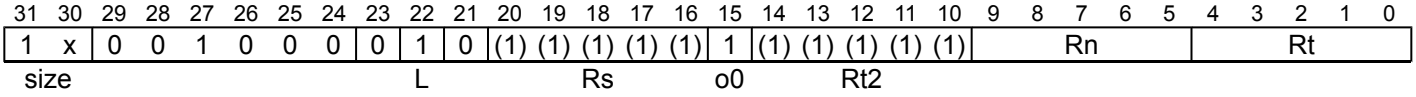
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDAXR

Load-Acquire Exclusive Register derives an address from a base register value, loads a 32-bit word or 64-bit doubleword from memory, and writes it to a register. The memory access is atomic. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (size == 10)

```
LDAXR <Wt>, [<Xn|SP>{,#0}]
```

64-bit (size == 11)

```
LDAXR <Xt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Wt>	Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xt>	Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

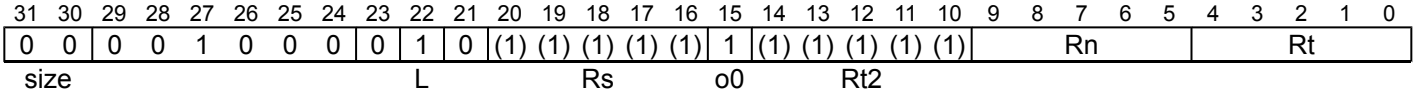
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDAXRB

Load-Acquire Exclusive Register Byte derives an address from a base register value, loads a byte from memory, zero-extends it and writes it to a register. The memory access is atomic. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



No offset

```
LDAXRB <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Wt>	Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

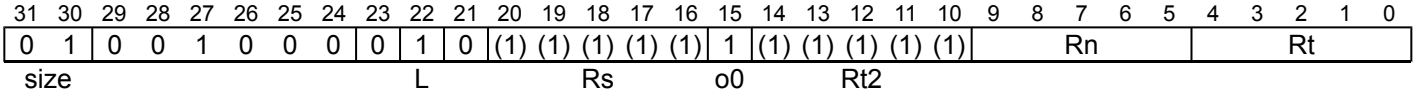
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDAXRH

Load-Acquire Exclusive Register Halfword derives an address from a base register value, loads a halfword from memory, zero-extends it and writes it to a register. The memory access is atomic. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



No offset

```
LDAXRH <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Wt>	Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDGM

Load Tag Multiple reads a naturally aligned block of N Allocation Tags, where the size of N is identified in GMID_EL1.BS, and writes the Allocation Tag read from address A to the destination register at 4*A<7:4>+3:4*A<7:4>. Bits of the destination register not written with an Allocation Tag are set to 0.

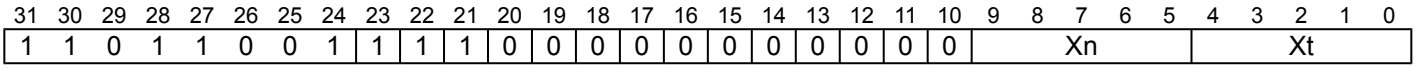
This instruction is UNDEFINED at EL0.

This instruction generates an Unchecked access.

This instruction is Unallocated when *ID_AA64PFR1_EL1.MTE* == 0b0001.

Integer

(Armv8.5)



Integer

```
LDGM <Xt>, [<Xn|SP>]

integer t = UInt(Xt);
integer n = UInt(Xn);
```

Assembler Symbols

<Xt>	Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Xt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Xn" field.

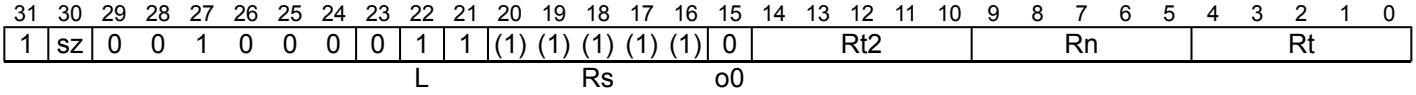
Operation

```
if PSTATE.EL == EL0 then
    UndefinedFault();

bits(64) data = Zeros(64);
bits(64) address;

if n == 31 then
    CheckSPAlignment();
    address = SP[];
else
    address = X[n];

integer size = 4*(2^(UInt(GMID_EL1.BS)));
address = Align(address,size);
integer count = size >> LOG2_TAG_GRANULE;
integer index = UInt(address<LOG2_TAG_GRANULE+3:LOG2_TAG_GRANULE>);

for i = 0 to count-1
    bits(4) tag = AArch64.MemTag[address];
    data<(index*4)+3:index*4> = tag;
    address = address + TAG_GRANULE;
    index = index + 1;

X[t] = data;
```

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LDXP

Load Exclusive Pair of Registers derives an address from a base register value, loads two 32-bit words or two 64-bit doublewords from memory, and writes them to two registers. A 32-bit pair requires the address to be doubleword aligned and is single-copy atomic at doubleword granularity. A 64-bit pair requires the address to be quadword aligned and is single-copy atomic for each doubleword at doubleword granularity. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (sz == 0)

```
LDXP <Wt1>, <Wt2>, [<Xn|SP>{,#0}]
```

64-bit (sz == 1)

```
LDXP <Xt1>, <Xt2>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = TRUE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 32 << UInt(sz);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *LDXP*.

Assembler Symbols

<Wt1>	Is the 32-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.
<Wt2>	Is the 32-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.
<Xt1>	Is the 64-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.
<Xt2>	Is the 64-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

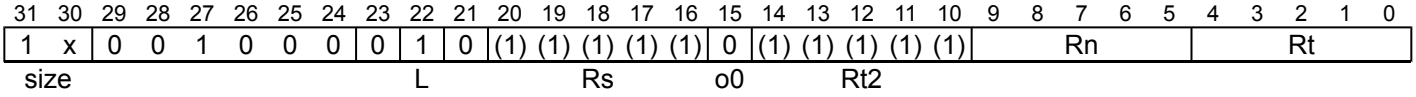
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDXR

Load Exclusive Register derives an address from a base register value, loads a 32-bit word or a 64-bit doubleword from memory, and writes it to a register. The memory access is atomic. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (size == 10)

```
LDXR <Wt>, [<Xn|SP>{,#0}]
```

64-bit (size == 11)

```
LDXR <Xt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Wt>	Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xt>	Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

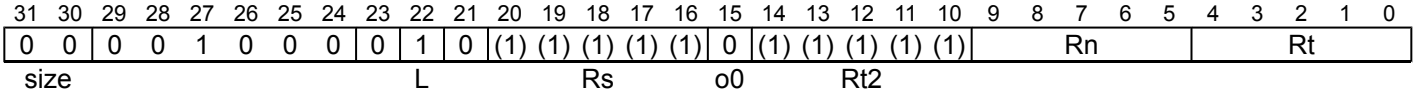
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDXRB

Load Exclusive Register Byte derives an address from a base register value, loads a byte from memory, zero-extends it and writes it to a register. The memory access is atomic. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. For information about memory accesses see *Load/Store addressing modes*.



No offset

```
LDXRB <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Wt>	Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

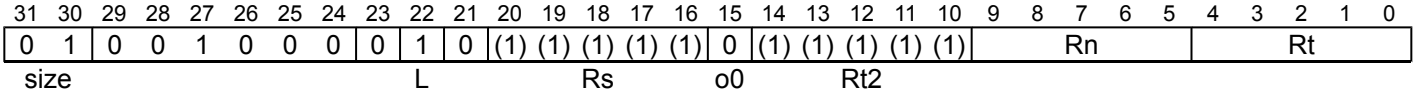
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

LDXRH

Load Exclusive Register Halfword derives an address from a base register value, loads a halfword from memory, zero-extends it and writes it to a register. The memory access is atomic. The PE marks the physical address being accessed as an exclusive access. This exclusive access mark is checked by Store Exclusive instructions. See *Synchronization and semaphores*. For information about memory accesses see *Load/Store addressing modes*.



No offset

```
LDXRH <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Wt>	Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

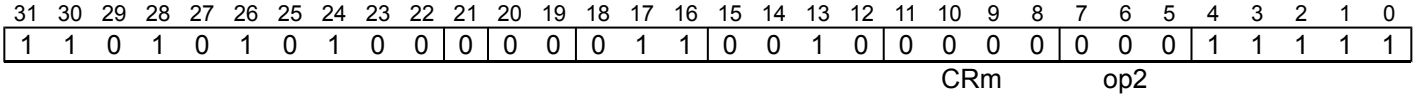
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

NOP

No Operation does nothing, other than advance the value of the program counter by 4. This instruction can be used for instruction alignment purposes. The timing effects of including a NOP instruction in a program are not guaranteed. It can increase execution time, leave it unchanged, or even reduce it. Therefore, NOP instructions are not suitable for timing loops.



System

NOP

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

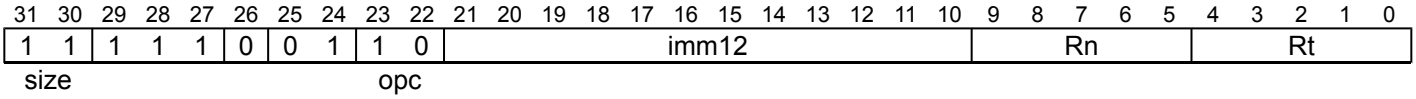
(old) htmldiff from- (new)

PRFM (immediate)

Prefetch Memory (immediate) signals the memory system that data memory accesses from a specified address are likely to occur in the near future. The memory system can respond by taking actions that are expected to speed up the memory accesses when they do occur, such as preloading the cache line containing the specified address into one or more caches.

The effect of an PRFM instruction is IMPLEMENTATION DEFINED. For more information, see *Prefetch memory*.

For information about memory accesses, see *Load/Store addressing modes*.



Unsigned offset

```
PRFM (<prfop>|#<imm5>), [<Xn|SP>{, #<pimm>}]
```

```
boolean wback = FALSE;
boolean postindex = FALSE;
integer scale = UInt(size);
bits(64) offset = LSL(ZeroExtend(imm12, 64), scale);
```

Assembler Symbols

<prfop> Is the prefetch operation, defined as <type><target><policy>.

<type> is one of:

PLD
Prefetch for load, encoded in the "Rt<4:3>" field as 0b00.

PLI
Preload instructions, encoded in the "Rt<4:3>" field as 0b01.

PST
Prefetch for store, encoded in the "Rt<4:3>" field as 0b10.

<target> is one of:

L1
Level 1 cache, encoded in the "Rt<2:1>" field as 0b00.

L2
Level 2 cache, encoded in the "Rt<2:1>" field as 0b01.

L3
Level 3 cache, encoded in the "Rt<2:1>" field as 0b10.

<policy> is one of:

KEEP
Retained or temporal prefetch, allocated in the cache normally. Encoded in the "Rt<0>" field as 0.

STRM
Streaming or non-temporal prefetch, for data that is used only once. Encoded in the "Rt<0>" field as 1.

For more information on these prefetch operations, see *Prefetch memory*.

For other encodings of the "Rt" field, use <imm5>.

<imm5> Is the prefetch operation encoding as an immediate, in the range 0 to 31, encoded in the "Rt" field.

This syntax is only for encodings that are not accessible using <prfop>.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

<pimm> Is the optional positive immediate byte offset, a multiple of 8 in the range 0 to 32760, defaulting to 0 and encoded in the "imm12" field as <pimm>/8.

Shared Decode

```
integer n = UInt(Rn);
integer t = UInt(Rt);
AccType acctype = AccType_NORMAL;
MemOp memop;
boolean signed;
integer regsize;

if opc<1> == '0' then
    // store or zero-extending load
    memop = if opc<0> == '1' then MemOp_LOAD else MemOp_STORE;
    regsize = if size == '11' then 64 else 32;
    signed = FALSE;
else
    if size == '11' then
        memop = MemOp_PREFETCH;
        if opc<0> == '1' then UNDEFINED;
    else
        // sign-extending load
        memop = MemOp_LOAD;
        if size == '10' && opc<0> == '1' then UNDEFINED;
        regsize = if opc<0> == '1' then 32 else 64;
        signed = TRUE;

integer datasize = 8 << scale;
boolean tag_checked = memop != MemOp_PREFETCH && (wback || n != 31);
```

Operation

```
if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

bits(64) address;
bits(datasize) data;

boolean wb_unknown = FALSE;
boolean rt_unknown = FALSE;

if memop == MemOp_LOAD && wback && n == t && n != 31 then
    c = ConstrainUnpredictable(Unpredictable_WBOVERLAPLD);
    assert c IN {Constraint_WBSUPPRESS, Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_WBSUPPRESS wback = FALSE;       // writeback is suppressed
        when Constraint_UNKNOWN    wb_unknown = TRUE;   // writeback is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE && wback && n == t && n != 31 then
    c = ConstrainUnpredictable(Unpredictable_WBOVERLAPST);
    assert c IN {Constraint_NONE, Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_NONE       rt_unknown = FALSE;  // value stored is original value
        when Constraint_UNKNOWN    rt_unknown = TRUE;   // value stored is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if n == 31 then
    if memop != MemOp_PREFETCH then CheckSPAlignment();
    address = SP[];
else
    address = X[n];

if ! postindex then
    address = address + offset;

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        else
            data = X[t];
        Mem[address, datasize DIV 8, acctype] = data;

    when MemOp_LOAD
        data = Mem[address, datasize DIV 8, acctype];
        if signed then
            X[t] = SignExtend(data, regsize);
        else
            X[t] = ZeroExtend(data, regsize);

    when MemOp_PREFETCHPrefetch(address, t<4:0>);

if wback then
    if wb_unknown then
        address = bits(64) UNKNOWN;
    elsif postindex then
        address = address + offset;
    if n == 31 then
        SP[] = address;
    else
        X[n] = address;
```

```
        no old file                     htmldiff from-                  (new)
```

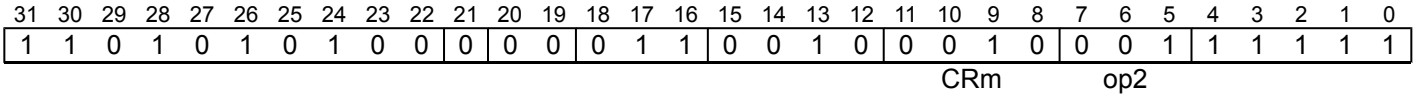
PSB CSYNC

Profiling Synchronization Barrier. This instruction is a barrier that ensures that all existing profiling data for the current PE has been formatted, and profiling buffer addresses have been translated such that all writes to the profiling buffer have been initiated. A following DSB instruction completes when the writes to the profiling buffer have completed.

If the Statistical Profiling Extension is not implemented, this instruction executes as a NOP.

System

(Armv8.2)



System

```
PSB CSYNC
```

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                 // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();   // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();        // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                 // Instruction executes as NOP
```

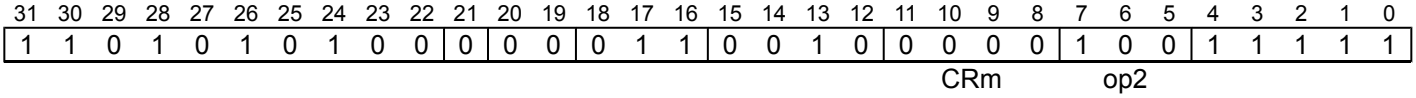
Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

SEV

Send Event is a hint instruction. It causes an event to be signaled to all PEs in the multiprocessor system. For more information, see *Wait for Event mechanism and Send event*.



System

SEV

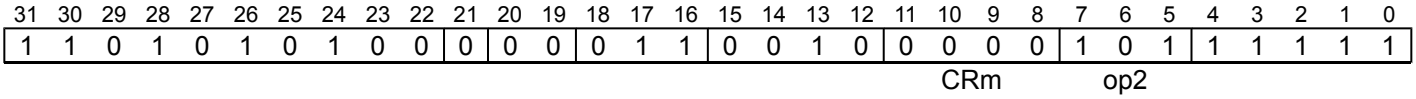
```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                 // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();   // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();        // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                 // Instruction executes as NOP
```

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

SEVL

Send Event Local is a hint instruction that causes an event to be signaled locally without requiring the event to be signaled to other PEs in the multiprocessor system. It can prime a wait-loop which starts with a WFE instruction.



System

SEVL

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

(old) htmldiff from- (new)

SMC

Secure Monitor Call causes an exception to EL3.

SMC is available only for software executing at EL1 or higher. It is UNDEFINED in EL0.

If the values of *HCR_EL2*.TSC and *SCR_EL3*.SMD are both 0, execution of an SMC instruction at EL1 or higher generates a Secure Monitor Call exception, recording it in *ESR_ELx*, using the EC value 0x17, that is taken to EL3.

If the value of *HCR_EL2*.TSC is 1 and EL2 is enabled in the current Security state, execution of an SMC instruction at~~in a Non-secure~~ EL1~~ state~~ generates an exception that is taken to EL2, regardless of the value of *SCR_EL3*.SMD. For more information, see *Traps to EL2 of Non-secure EL1 execution of SMC instructions*.

If the value of *HCR_EL2*.TSC is 0 and the value of *SCR_EL3*.SMD is 1, the SMC instruction is UNDEFINED.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	0	0	0	0	0	imm16																0	0	0	1	1

System

```
SMC #<imm>

bits(16) imm = imm16;
```

Assembler Symbols

<imm>	Is a 16-bit unsigned immediate, in the range 0 to 65535, encoded in the "imm16" field.

Operation

```
AArch64.CheckForSMCUndefOrTrap(imm);

if SCR_EL3.SMD == '1' then
    // SMC disabled
    AArch64.UndefinedFault();
else
    AArch64.CallSecureMonitor(imm);
```

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

STGM

Store Tag Multiple writes a naturally aligned block of N Allocation Tags, where the size of N is identified in GMID_EL1.BS, and the Allocation Tag written to address A is taken from the source register at 4*A<7:4>+3:4*A<7:4>.

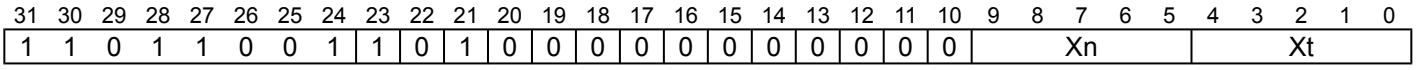
This instruction is UNDEFINED at EL0.

This instruction generates an Unchecked access.

This instruction is Unallocated when *ID_AA64PFR1_EL1.MTE* == 0b0001.

Integer

(Armv8.5)



Integer

```
STGM <Xt>, [<Xn|SP>]

integer t = UInt(Xt);
integer n = UInt(Xn);
```

Assembler Symbols

<Xt>	Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Xt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Xn" field.

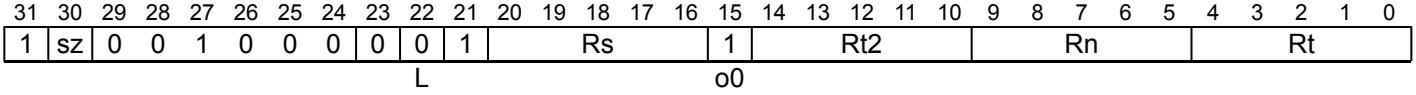
Operation

```
if PSTATE.EL == EL0 then
    UndefinedFault();

bits(64) data = X[t];
bits(64) address;

if n == 31 then
    CheckSPAlignment();
    address = SP[];
else
    address = X[n];

integer size = 4*(2^(UInt(GMID_EL1.BS)));
address = Align(address,size);
integer count = size >> LOG2_TAG_GRANULE;
integer index = UInt(address<LOG2_TAG_GRANULE+3:LOG2_TAG_GRANULE>);

for i = 0 to count-1
    bits(4) tag = data<(index*4)+3:index*4>;
    AArch64.MemTag[address] = tag;
    address = address + TAG_GRANULE;
    index = index + 1;
```

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

STLXP

Store-Release Exclusive Pair of registers stores two 32-bit words or two 64-bit doublewords to a memory location if the PE has exclusive access to the memory address, from two registers, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. A 32-bit pair requires the address to be doubleword aligned and is single-copy atomic at doubleword granularity. A 64-bit pair requires the address to be quadword aligned and, if the Store-Exclusive succeeds, it causes a single-copy atomic update of the 128-bit memory location being updated. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (sz == 0)

```
STLXP <Ws>, <Wt1>, <Wt2>, [<Xn|SP>{,#0}]
```

64-bit (sz == 1)

```
STLXP <Ws>, <Xt1>, <Xt2>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = TRUE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 32 << UInt(sz);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STLXP*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Xt1> Is the 64-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.

<Xt2> Is the 64-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.

<Wt1> Is the 32-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.

<Wt2> Is the 32-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts and alignment

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

Accessing an address that is not aligned to the size of the data being accessed causes an Alignment fault Data Abort exception to be generated, subject to the following rules:

- If AArch64.ExclusiveMonitorsPass() returns TRUE, the exception is generated.
- Otherwise, it is IMPLEMENTATION DEFINED whether the exception is generated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

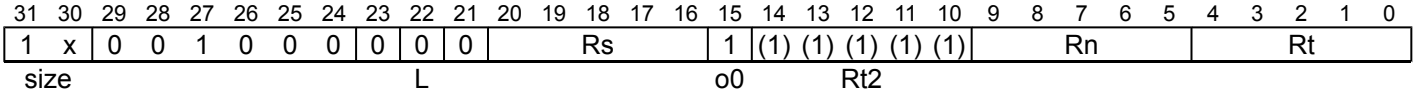
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STLXR

Store-Release Exclusive Register stores a 32-bit word or a 64-bit doubleword to memory if the PE has exclusive access to the memory address, from two registers, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. The memory access is atomic. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (size == 10)

```
STLXR <Ws>, <Wt>, [<Xn|SP>{,#0}]
```

64-bit (size == 11)

```
STLXR <Ws>, <Xt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STLXR*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Xt> Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Wt> Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts and alignment

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

Accessing an address that is not aligned to the size of the data being accessed causes an Alignment fault Data Abort exception to be generated, subject to the following rules:

- If AArch64.ExclusiveMonitorsPass() returns TRUE, the exception is generated.
- Otherwise, it is IMPLEMENTATION DEFINED whether the exception is generated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

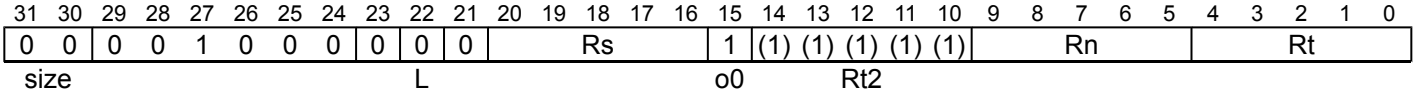
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STLXRB

Store-Release Exclusive Register Byte stores a byte from a 32-bit register to memory if the PE has exclusive access to the memory address, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. The memory access is atomic. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



No offset

```
STLXRB <Ws>, <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STLXRB*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Wt> Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

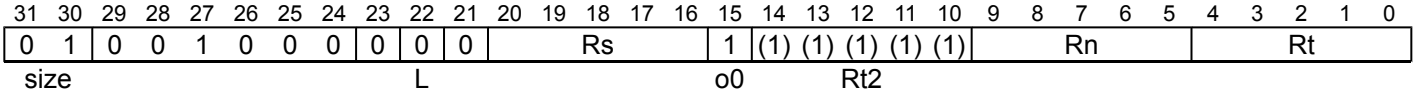
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

(old) htmldiff from- (new)

STLXRH

Store-Release Exclusive Register Halfword stores a halfword from a 32-bit register to memory if the PE has exclusive access to the memory address, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. The memory access is atomic. The instruction also has memory ordering semantics as described in *Load-Acquire, Store-Release*. For information about memory accesses see *Load/Store addressing modes*.



No offset

```
STLXRH <Ws>, <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STLXRH*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Wt> Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts and alignment

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

A non halfword-aligned memory address causes an Alignment fault Data Abort exception to be generated, subject to the following rules:

- If AArch64.ExclusiveMonitorsPass() returns TRUE, the exception is generated.
- Otherwise, it is IMPLEMENTATION DEFINED whether the exception is generated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

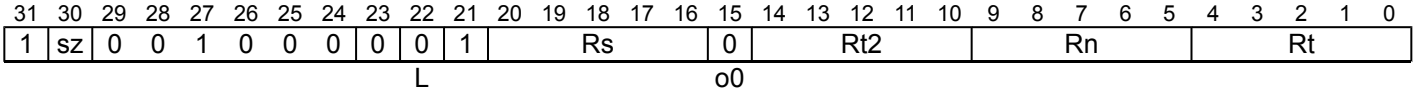
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STXP

Store Exclusive Pair of registers stores two 32-bit words or two 64-bit doublewords from two registers to a memory location if the PE has exclusive access to the memory address, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. A 32-bit pair requires the address to be doubleword aligned and is single-copy atomic at doubleword granularity. A 64-bit pair requires the address to be quadword aligned and, if the Store-Exclusive succeeds, it causes a single-copy atomic update of the 128-bit memory location being updated. For information about memory accesses see *Load/Store addressing modes*.



32-bit (sz == 0)

```
STXP <Ws>, <Wt1>, <Wt2>, [<Xn|SP>{,#0}]
```

64-bit (sz == 1)

```
STXP <Ws>, <Xt1>, <Xt2>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = TRUE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 32 << UInt(sz);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STXP*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Xt1> Is the 64-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.

<Xt2> Is the 64-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.

<Wt1> Is the 32-bit name of the first general-purpose register to be transferred, encoded in the "Rt" field.

<Wt2> Is the 32-bit name of the second general-purpose register to be transferred, encoded in the "Rt2" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts and alignment

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

Accessing an address that is not aligned to the size of the data being accessed causes an Alignment fault Data Abort exception to be generated, subject to the following rules:

- If AArch64.ExclusiveMonitorsPass() returns TRUE, the exception is generated.

- Otherwise, it is IMPLEMENTATION DEFINED whether the exception is generated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

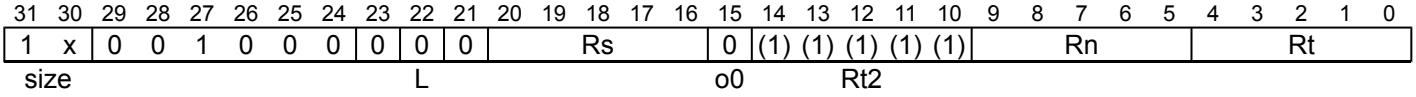
If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STXR

Store Exclusive Register stores a 32-bit word or a 64-bit doubleword from a register to memory if the PE has exclusive access to the memory address, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. For information about memory accesses see *Load/Store addressing modes*.



32-bit (size == 10)

```
STXR <Ws>, <Wt>, [<Xn|SP>{,#0}]
```

64-bit (size == 11)

```
STXR <Ws>, <Xt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STXR*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Xt> Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Wt> Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts and alignment

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

Accessing an address that is not aligned to the size of the data being accessed causes an Alignment fault Data Abort exception to be generated, subject to the following rules:

- If AArch64.ExclusiveMonitorsPass() returns TRUE, the exception is generated.
- Otherwise, it is IMPLEMENTATION DEFINED whether the exception is generated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

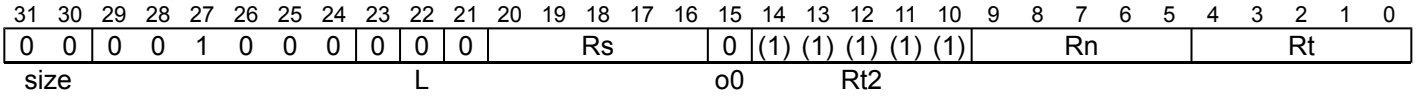
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STXRB

Store Exclusive Register Byte stores a byte from a register to memory if the PE has exclusive access to the memory address, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. The memory access is atomic.

For information about memory accesses see *Load/Store addressing modes*.



No offset

```
STXRB <Ws>, <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

For information about the CONSTRAINED UNPREDICTABLE behavior of this instruction, see *Architectural Constraints on UNPREDICTABLE behaviors*, and particularly *STXRB*.

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Wt> Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

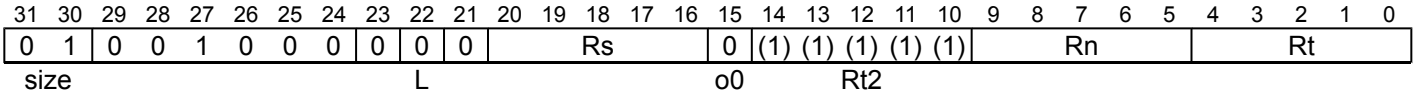
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STXRH

Store Exclusive Register Halfword stores a halfword from a register to memory if the PE has exclusive access to the memory address, and returns a status value of 0 if the store was successful, or of 1 if no store was performed. See *Synchronization and semaphores*. The memory access is atomic.

For information about memory accesses see *Load/Store addressing modes*.



No offset

```
STXRH <Ws>, <Wt>, [<Xn|SP>{,#0}]
```

```
integer n = UInt(Rn);
integer t = UInt(Rt);
integer t2 = UInt(Rt2); // ignored by load/store single register
integer s = UInt(Rs);   // ignored by all loads and store-release

AccType acctype = if o0 == '1' then AccType_ORDEREDATOMIC else AccType_ATOMIC;
boolean pair = FALSE;
MemOp memop = if L == '1' then MemOp_LOAD else MemOp_STORE;
integer elsize = 8 << UInt(size);
integer regsize = if elsize == 64 then 64 else 32;
integer datasize = if pair then elsize * 2 else elsize;
boolean tag_checked = n != 31;
```

Assembler Symbols

<Ws> Is the 32-bit name of the general-purpose register into which the status result of the store exclusive is written, encoded in the "Rs" field. The value returned is:

0
If the operation updates memory.

1
If the operation fails to update memory.

<Wt> Is the 32-bit name of the general-purpose register to be transferred, encoded in the "Rt" field.

<Xn|SP> Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Rn" field.

Aborts and alignment

If a synchronous Data Abort exception is generated by the execution of this instruction:

- Memory is not updated.
- <Ws> is not updated.

A non halfword-aligned memory address causes an Alignment fault Data Abort exception to be generated, subject to the following rules:

- If AArch64.ExclusiveMonitorsPass() returns TRUE, the exception is generated.
- Otherwise, it is IMPLEMENTATION DEFINED whether the exception is generated.

If AArch64.ExclusiveMonitorsPass() returns FALSE and the memory address, if accessed, would generate a synchronous Data Abort exception, it is IMPLEMENTATION DEFINED whether the exception is generated.

Operation

```
bits(64) address;
bits(datasize) data;
constant integer dbytes = datasize DIV 8;
boolean rt_unknown = FALSE;
boolean rn_unknown = FALSE;

if HaveMTEExt() then
    SetNotTagCheckedInstruction(!tag_checked);

if memop == MemOp_LOAD && pair && t == t2 then
    Constraint c = ConstrainUnpredictable(Unpredictable_LDPOVERLAP);
    assert c IN {Constraint_UNKNOWN, Constraint_UNDEF, Constraint_NOP};
    case c of
        when Constraint_UNKNOWN    rt_unknown = TRUE;    // result is UNKNOWN
        when Constraint_UNDEF      UNDEFINED;
        when Constraint_NOP        EndOfInstruction();

if memop == MemOp_STORE then
    if s == t || (pair && s == t2) then
        Constraint c = ConstrainUnpredictable(Unpredictable_DATAOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rt_unknown = TRUE;    // store UNKNOWN value
            when Constraint_NONE       rt_unknown = FALSE;   // store original value
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();
    if s == n && n != 31 then
        Constraint c = ConstrainUnpredictable(Unpredictable_BASEOVERLAP);
        assert c IN {Constraint_UNKNOWN, Constraint_NONE, Constraint_UNDEF, Constraint_NOP};
        case c of
            when Constraint_UNKNOWN    rn_unknown = TRUE;    // address is UNKNOWN
            when Constraint_NONE       rn_unknown = FALSE;   // address is original base
            when Constraint_UNDEF      UNDEFINED;
            when Constraint_NOP        EndOfInstruction();

if n == 31 then
    CheckSPAlignment();
    address = SP[];
elsif rn_unknown then
    address = bits(64) UNKNOWN;
else
    address = X[n];

case memop of
    when MemOp_STORE
        if rt_unknown then
            data = bits(datasize) UNKNOWN;
        elsif pair then
            bits(datasize DIV 2) el1 = X[t];
            bits(datasize DIV 2) el2 = X[t2];
            data = if BigEndian() then el1 : el2 else el2 : el1;
        else
            data = X[t];

        bit status = '1';
        // Check whether the Exclusives monitors are set to include the
        // physical memory locations corresponding to virtual address
        // range [address, address+dbytes-1].
        if AArch64.ExclusiveMonitorsPass(address, dbytes) then
            // This atomic write will be rejected if it does not refer
            // to the same physical locations after address translation.
            Mem[address, dbytes, acctype] = data;
            status = ExclusiveMonitorsStatus();
        X[s] = ZeroExtend(status, 32);

    when MemOp_LOAD
        // Tell the Exclusives monitors to record a sequence of one or more atomic
        // memory reads from virtual address range [address, address+dbytes-1].
        // The Exclusives monitor will only be set if all the reads are from the
        // same dbytes-aligned physical address, to allow for the possibility of
```

```
        // an atomicity break if the translation is changed between reads.
        AArch64.SetExclusiveMonitors(address, dbytes);

        if pair then
            if rt_unknown then
                // ConstrainedUNPREDICTABLE case
                X[t]  = bits(datasize) UNKNOWN;         // In this case t = t2
[t]  = bits(datasize) UNKNOWN;
            elsif elsize == 32 then
                // 32-bit load exclusive pair (atomic)
                data = Mem[address, dbytes, acctype];
                if BigEndian() then
                    X[t]  = data<datasize-1:elsize>;
                    X[t2] = data<elsize-1:0>;
                else
                    X[t]  = data<elsize-1:0>;
                    X[t2] = data<datasize-1:elsize>;
            else // elsize == 64
                // 64-bit load exclusive pair (not atomic),
                // but must be 128-bit aligned
                if address != Align(address, dbytes) then
                    iswrite = FALSE;
                    secondstage = FALSE;
                    AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));
                X[t]  = Mem[address + 0, 8, acctype];
                X[t2] = Mem[address + 8, 8, acctype];
        else
            data = Mem[address, dbytes, acctype];
            X[t] = ZeroExtend(data, regsize);
```

Operational information

If PSTATE.DIT is 1, the timing of this instruction is insensitive to the value of the data being loaded or stored.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

STZGM

Store Tag and Zero Multiple writes a naturally aligned block of N Allocation Tags and stores zero to the associated data locations, where the size of N is identified in DCZID_EL0.BS, and the Allocation Tag written to address A is taken from the source register bits<3:0>.

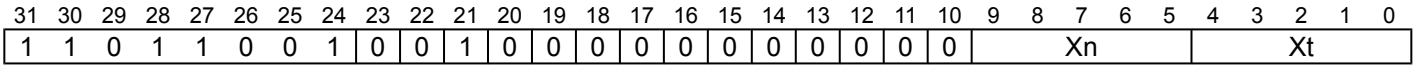
This instruction is UNDEFINED at EL0.

This instruction generates an Unchecked access.

This instruction is Unallocated when *ID_AA64PFR1_EL1.MTE* == 0b0001.

Integer

(Armv8.5)



Integer

```
STZGM <Xt>, [<Xn|SP>]

integer t = UInt(Xt);
integer n = UInt(Xn);
```

Assembler Symbols

<Xt>	Is the 64-bit name of the general-purpose register to be transferred, encoded in the "Xt" field.
<Xn|SP>	Is the 64-bit name of the general-purpose base register or stack pointer, encoded in the "Xn" field.

Operation

```
if PSTATE.EL == EL0 then
    UndefinedFault();

bits(64) data = X[t];
bits(4) tag = data<3:0>;
bits(64) address;
if n == 31 then
    CheckSPAlignment();
    address = SP[];
else
    address = X[n];

integer size = 4*(2^(UInt(DCZID_EL0.BS)));
address = Align(address,size);
integer count = size >> LOG2_TAG_GRANULE;

for i = 0 to count-1
    AArch64.MemTag[address] = tag;
    Mem[address, TAG_GRANULE, AccType_NORMAL] = Zeros(8*TAG_GRANULE);
    address = address + TAG_GRANULE;
```

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

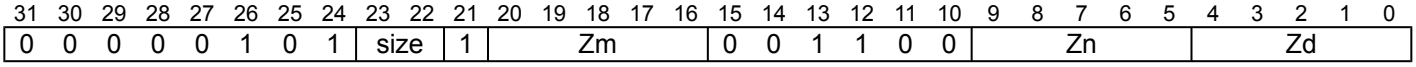
TBL

Programmable table lookup in one or two vector table (zeroing).

Reads each element of the second source (index) vector and uses its value to select an indexed element from a table of elements consisting of one or two consecutive vector registers, where the first or only vector holds the lower numbered elements, and places the indexed table element in the destination vector element corresponding to the index vector element. If an index value is greater than or equal to the number of vector elements then it places zero in the corresponding destination vector element.
Since the index values can select any element in a vector this operation is not naturally vector length agnostic.

It has encodings from 2 classes: SVE and SVE2

SVE

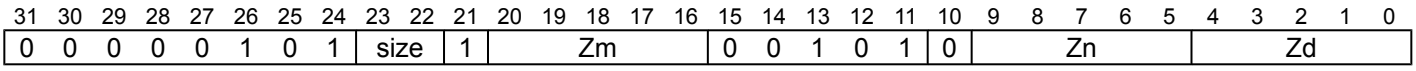


SVE

```
TBL <Zd>.<T>, { <Zn>.<T> }, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean double_table = FALSE;
```

SVE2



SVE2

```
TBL <Zd>.<T>, { <Zn1>.<T>, <Zn2>.<T> }, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean double_table = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zn1> Is the name of the first scalable vector register of a multi-vector sequence, encoded in the "Zn" field.

<Zn2> Is the name of the second scalable vector register of a multi-vector sequence, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) indexes = Z[m];
bits(VL) result;
integer table_size = if double_table then VL*2 else VL;
integer table_elems = table_size DIV esize;
bits(table_size) table;

if double_table then
    bits(VL) top = Z[(n + 1) MOD 32];
    bits(VL) bottom = Z[n];
    table = (top:bottom)<table_size-1:0>;
else
    table = Z[n];

for e = 0 to elements-1
    integer idx = UInt(Elem[indexes, e, esize]);
    Elem[result, e, esize] = if idx < table_elems then Elem[table, idx, esize] else Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

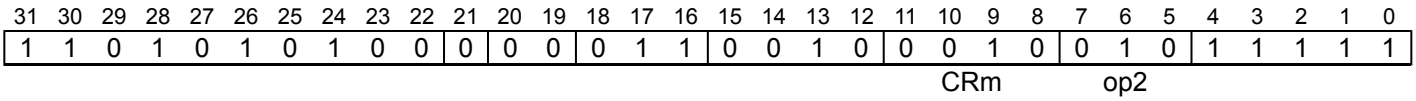
TSB CSYNC

Trace Synchronization Barrier. This instruction is a barrier that synchronizes the trace operations of instructions.

If ARMv8.4-Trace~~the Self-Hosted Trace Extension~~ is not implemented, this instruction executes as a NOP.

System

(Armv8.4)



System

TSB CSYNC

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

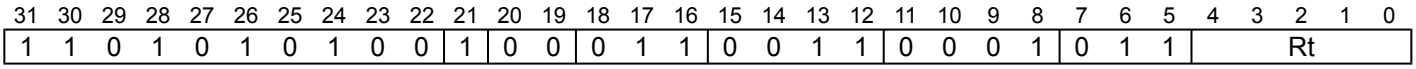
```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

TTEST

This instruction takes no inputs and writes to the depthdestination ofregister the value 1 when executed in an outer transaction, to the destinationvalue register2 when executed in a nested transaction, or the value 0 otherwise.

System

(TME)



System

```
TTEST <Xt>

if !HaveTME() then UNDEFINED;
integer t = UInt(Rt);
```

Assembler Symbols

<Xt>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rt" field.

Operation

```
CheckTMEEnabled();

X[t] = (TSTATE.depth)<63:0>;
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

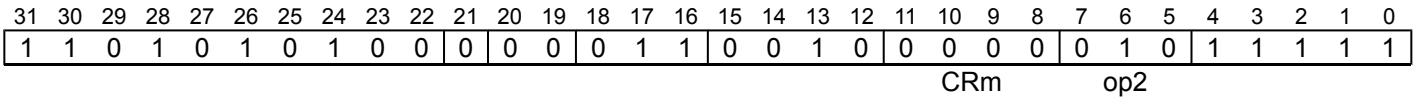
(old) htmldiff from- (new)

WFE

Wait For Event is a hint instruction that indicates that the PE can enter a low-power state and remain there until a wakeup event occurs. Wakeup events include the event signaled as a result of executing the SEV instruction on any PE in the multiprocessor system. For more information, see *Wait For Event mechanism and Send event*.

As described in *Wait For Event mechanism and Send event*, the execution of a WFE instruction that would otherwise cause entry to a low-power state can be trapped to a higher Exception level. See:

- *Traps to EL1 of EL0 execution of WFE and WFI instructions*.
- *Traps to EL2 of Non-secure EL0 and EL1 execution of WFE and WFI instructions*.
- *Traps to EL3 of EL2, EL1, and EL0 execution of WFE and WFI instructions*.



System

WFE

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

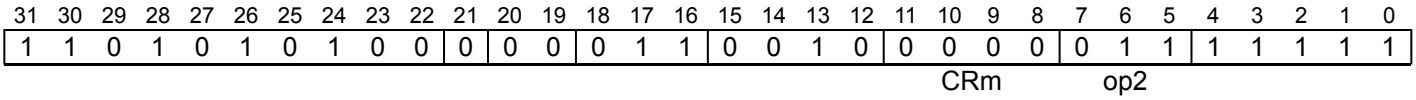
```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

WFI

Wait For Interrupt is a hint instruction that indicates that the PE can enter a low-power state and remain there until a wakeup event occurs. For more information, see *Wait For Interrupt*.

As described in *Wait For Interrupt*, the execution of a `WFI` instruction that would otherwise cause entry to a low-power state can be trapped to a higher Exception level. See:

- *Traps to EL1 of EL0 execution of WFE and WFI instructions*.
- *Traps to EL2 of Non-secure EL0 and EL1 execution of WFE and WFI instructions*.
- *Traps to EL3 of EL2, EL1, and EL0 execution of WFE and WFI instructions*.



System

```
WFI
```

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

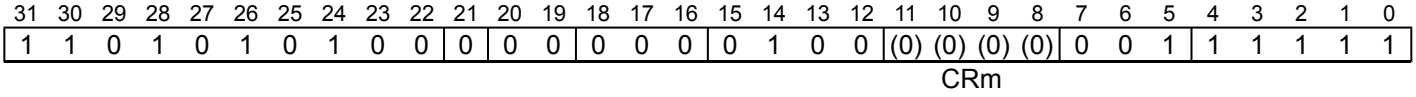
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

XAFLAGXAFlag

Convert floating-point condition flags from external format to Arm format. This instruction converts the state of the PSTATE.{N,Z,C,V} flags from an alternative representation required by some software to a form representing the result of an Arm floating-point scalar compare instruction.

System

(Armv8.5)



System

XAFLAGXAFlag

```
if !HaveFlagFormatExt() then UNDEFINED;
```

Operation

```
bit N = NOT(PSTATE.C) AND NOT(PSTATE.Z);
bit Z = PSTATE.Z AND PSTATE.C;
bit C = PSTATE.C OR PSTATE.Z;
bit V = NOT(PSTATE.C) AND PSTATE.Z;

PSTATE.N = N;
PSTATE.Z = Z;
PSTATE.C = C;
PSTATE.V = V;
```

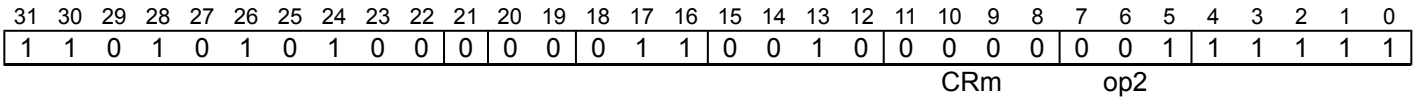
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

YIELD

YIELD is a hint instruction. Software with a multithreading capability can use a YIELD instruction to indicate to the PE that it is performing a task, for example a spin-lock, that could be swapped out to improve overall system performance. The PE can use this hint to suspend and resume multiple software threads if it supports the capability.

For more information about the recommended use of this instruction, see *The YIELD instruction*.



System

YIELD

```
SystemHintOp op;

case CRm:op2 of
    when '0000 000' op = SystemHintOp_NOP;
    when '0000 001' op = SystemHintOp_YIELD;
    when '0000 010' op = SystemHintOp_WFE;
    when '0000 011' op = SystemHintOp_WFI;
    when '0000 100' op = SystemHintOp_SEV;
    when '0000 101' op = SystemHintOp_SEVL;
    when '0000 111'
        SEE "XPACLRI";
    when '0001 xxx'
        SEE "PACIA1716, PACIB1716, AUTIA1716, AUTIB1716";
    when '0010 000'
        if !HaveRASExt() then EndOfInstruction();                  // Instruction executes as NOP
        op = SystemHintOp_ESB;
    when '0010 001'
        if !HaveStatisticalProfiling() then EndOfInstruction();    // Instruction executes as NOP
        op = SystemHintOp_PSB;
    when '0010 010'
        if !HaveSelfHostedTrace() then EndOfInstruction();         // Instruction executes as NOP
        op = SystemHintOp_TSB;
    when '0010 100'
        op = SystemHintOp_CSDB;
    when '0011 xxx'
        SEE "PACIAZ, PACIASP, PACIBZ, PACIBSP, AUTIAZ, AUTIASP, AUTIBZ, AUTIBSP";
    when '0100 xx0'
        op = SystemHintOp_BTI;
        // Check branch target compatibility between BTI instruction and PSTATE.BTYPE
        BTypeCompatible = BTypeCompatible_BTI(op2<2:1>);
    otherwise EndOfInstruction();                                  // Instruction executes as NOP
```

Operation

```
case op of
    when SystemHintOp_YIELDHint_Yield();

    when SystemHintOp_WFE
        if IsEventRegisterSet() then
            ClearEventRegister();
        else
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, TRUE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, TRUE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, TRUE);
            WaitForEvent();

    when SystemHintOp_WFI
        if !InterruptPending() then
            if PSTATE.EL == EL0 then
                // Check for traps described by the OS which may be EL1 or EL2.
                AArch64.CheckForWFxTrap(EL1, FALSE);
            if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !IsInHost() then
                // Check for traps described by the Hypervisor.
                AArch64.CheckForWFxTrap(EL2, FALSE);
            if HaveEL(EL3) && PSTATE.EL != EL3 then
                // Check for traps described by the Secure Monitor.
                AArch64.CheckForWFxTrap(EL3, FALSE);
            WaitForInterrupt();

    when SystemHintOp_SEVSendEvent();

    when SystemHintOp_SEVLSendEventLocal();

    when SystemHintOp_ESB
        if TSTATE.depth > 0 then
            FailTransaction(TMFailure_ERR, FALSE);
        SynchronizeErrors();
        AArch64.ESBOperation();
        if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then AArch64.vESBOperation();
        TakeUnmaskedSErrorInterrupts();

    when SystemHintOp_PSBProfilingSynchronizationBarrier();

    when SystemHintOp_TSBTraceSynchronizationBarrier();
TraceSynchronizationBarrier();

    when SystemHintOp_CSDBConsumptionOfSpeculativeDataBarrier();

    when SystemHintOp_BTI
        BTypeNext = '00';

    otherwise // do nothing
```

A64 -- SIMD and Floating-point Instructions (alphabetic order)

ABS: Absolute value (vector).

ADD (vector): Add (vector).

ADDHN, ADDHN2: Add returning High Narrow.

ADDP (scalar): Add Pair of elements (scalar).

ADDP (vector): Add Pairwise (vector).

ADDV: Add across Vector.

AESD: AES single round decryption.

AESE: AES single round encryption.

AESIMC: AES inverse mix columns.

AESMC: AES mix columns.

AND (vector): Bitwise AND (vector).

BCAX: Bit Clear and XOR.

BIC (vector, immediate): Bitwise bit Clear (vector, immediate).

BIC (vector, register): Bitwise bit Clear (vector, register).

BIF: Bitwise Insert if False.

BIT: Bitwise Insert if True.

BSL: Bitwise Select.

CLS (vector): Count Leading Sign bits (vector).

CLZ (vector): Count Leading Zero bits (vector).

CMEQ (register): Compare bitwise Equal (vector).

CMEQ (zero): Compare bitwise Equal to zero (vector).

CMGE (register): Compare signed Greater than or Equal (vector).

CMGE (zero): Compare signed Greater than or Equal to zero (vector).

CMGT (register): Compare signed Greater than (vector).

CMGT (zero): Compare signed Greater than zero (vector).

CMHI (register): Compare unsigned Higher (vector).

CMHS (register): Compare unsigned Higher or Same (vector).

CMLE (zero): Compare signed Less than or Equal to zero (vector).

CMLT (zero): Compare signed Less than zero (vector).

CMTST: Compare bitwise Test bits nonzero (vector).

CNT: Population Count per byte.

DUP (element): Duplicate vector element to vector or scalar.

DUP (general): Duplicate general-purpose register to vector.

EOR (vector): Bitwise Exclusive OR (vector).

EOR3: Three-way Exclusive OR.

EXT: Extract vector from pair of vectors.

FABD: Floating-point Absolute Difference (vector).

FABS (scalar): Floating-point Absolute value (scalar).

FABS (vector): Floating-point Absolute value (vector).

FACGE: Floating-point Absolute Compare Greater than or Equal (vector).

FACGT: Floating-point Absolute Compare Greater than (vector).

FADD (scalar): Floating-point Add (scalar).

FADD (vector): Floating-point Add (vector).

FADDP (scalar): Floating-point Add Pair of elements (scalar).

FADDP (vector): Floating-point Add Pairwise (vector).

FCADD: Floating-point Complex Add.

FCCMP: Floating-point Conditional quiet Compare (scalar).

FCCMPE: Floating-point Conditional signaling Compare (scalar).

FCMEQ (register): Floating-point Compare Equal (vector).

FCMEQ (zero): Floating-point Compare Equal to zero (vector).

FCMGE (register): Floating-point Compare Greater than or Equal (vector).

FCMGE (zero): Floating-point Compare Greater than or Equal to zero (vector).

FCMGT (register): Floating-point Compare Greater than (vector).

FCMGT (zero): Floating-point Compare Greater than zero (vector).

FCMLA: Floating-point Complex Multiply Accumulate.

FCMLA (by element): Floating-point Complex Multiply Accumulate (by element).

FCMLE (zero): Floating-point Compare Less than or Equal to zero (vector).

FCMLT (zero): Floating-point Compare Less than zero (vector).

FCMP: Floating-point quiet Compare (scalar).

FCMPE: Floating-point signaling Compare (scalar).

FCSEL: Floating-point Conditional Select (scalar).

FCVT: Floating-point Convert precision (scalar).

FCVTAS (scalar): Floating-point Convert to Signed integer, rounding to nearest with ties to Away (scalar).

FCVTAS (vector): Floating-point Convert to Signed integer, rounding to nearest with ties to Away (vector).

FCVTAU (scalar): Floating-point Convert to Unsigned integer, rounding to nearest with ties to Away (scalar).

FCVTAU (vector): Floating-point Convert to Unsigned integer, rounding to nearest with ties to Away (vector).

FCVTL, FCVTL2: Floating-point Convert to higher precision Long (vector).

FCVTMS (scalar): Floating-point Convert to Signed integer, rounding toward Minus infinity (scalar).

FCVTMS (vector): Floating-point Convert to Signed integer, rounding toward Minus infinity (vector).

FCVTMU (scalar): Floating-point Convert to Unsigned integer, rounding toward Minus infinity (scalar).

FCVTMU (vector): Floating-point Convert to Unsigned integer, rounding toward Minus infinity (vector).

FCVTN, FCVTN2: Floating-point Convert to lower precision Narrow (vector).

FCVTNS (scalar): Floating-point Convert to Signed integer, rounding to nearest with ties to even (scalar).

FCVTNS (vector): Floating-point Convert to Signed integer, rounding to nearest with ties to even (vector).

FCVTNU (scalar): Floating-point Convert to Unsigned integer, rounding to nearest with ties to even (scalar).

FCVTNU (vector): Floating-point Convert to Unsigned integer, rounding to nearest with ties to even (vector).

FCVTPS (scalar): Floating-point Convert to Signed integer, rounding toward Plus infinity (scalar).

FCVTPS (vector): Floating-point Convert to Signed integer, rounding toward Plus infinity (vector).

FCVTPU (scalar): Floating-point Convert to Unsigned integer, rounding toward Plus infinity (scalar).

FCVTPU (vector): Floating-point Convert to Unsigned integer, rounding toward Plus infinity (vector).

FCVTXN, FCVTXN2: Floating-point Convert to lower precision Narrow, rounding to odd (vector).

FCVTZS (scalar, fixed-point): Floating-point Convert to Signed fixed-point, rounding toward Zero (scalar).

FCVTZS (scalar, integer): Floating-point Convert to Signed integer, rounding toward Zero (scalar).

FCVTZS (vector, fixed-point): Floating-point Convert to Signed fixed-point, rounding toward Zero (vector).

FCVTZS (vector, integer): Floating-point Convert to Signed integer, rounding toward Zero (vector).

FCVTZU (scalar, fixed-point): Floating-point Convert to Unsigned fixed-point, rounding toward Zero (scalar).

FCVTZU (scalar, integer): Floating-point Convert to Unsigned integer, rounding toward Zero (scalar).

FCVTZU (vector, fixed-point): Floating-point Convert to Unsigned fixed-point, rounding toward Zero (vector).

FCVTZU (vector, integer): Floating-point Convert to Unsigned integer, rounding toward Zero (vector).

FDIV (scalar): Floating-point Divide (scalar).

FDIV (vector): Floating-point Divide (vector).

FJCVTZS: Floating-point Javascript Convert to Signed fixed-point, rounding toward Zero.

FMADD: Floating-point fused Multiply-Add (scalar).

FMAX (scalar): Floating-point Maximum (scalar).

FMAX (vector): Floating-point Maximum (vector).

FMAXNM (scalar): Floating-point Maximum Number (scalar).

FMAXNM (vector): Floating-point Maximum Number (vector).

FMAXNMP (scalar): Floating-point Maximum Number of Pair of elements (scalar).

FMAXNMP (vector): Floating-point Maximum Number Pairwise (vector).

FMAXNMV: Floating-point Maximum Number across Vector.

FMAXP (scalar): Floating-point Maximum of Pair of elements (scalar).

FMAXP (vector): Floating-point Maximum Pairwise (vector).

FMAXV: Floating-point Maximum across Vector.

FMIN (scalar): Floating-point Minimum (scalar).

FMIN (vector): Floating-point minimum (vector).

FMINNM (scalar): Floating-point Minimum Number (scalar).

FMINNM (vector): Floating-point Minimum Number (vector).

FMINNMP (scalar): Floating-point Minimum Number of Pair of elements (scalar).

FMINNMP (vector): Floating-point Minimum Number Pairwise (vector).

FMINNMV: Floating-point Minimum Number across Vector.

FMINP (scalar): Floating-point Minimum of Pair of elements (scalar).

FMINP (vector): Floating-point Minimum Pairwise (vector).

FMINV: Floating-point Minimum across Vector.

FMLA (by element): Floating-point fused Multiply-Add to accumulator (by element).

FMLA (vector): Floating-point fused Multiply-Add to accumulator (vector).

FMLAL, FMLAL2 (by element): Floating-point fused Multiply-Add Long to accumulator (by element).

FMLAL, FMLAL2 (vector): Floating-point fused Multiply-Add Long to accumulator (vector).

FMLS (by element): Floating-point fused Multiply-Subtract from accumulator (by element).

FMLS (vector): Floating-point fused Multiply-Subtract from accumulator (vector).

FMLSL, FMLSL2 (by element): Floating-point fused Multiply-Subtract Long from accumulator (by element).

FMLSL, FMLSL2 (vector): Floating-point fused Multiply-Subtract Long from accumulator (vector).

FMOV (general): Floating-point Move to or from general-purpose register without conversion.

FMOV (register): Floating-point Move register without conversion.

FMOV (scalar, immediate): Floating-point move immediate (scalar).

FMOV (vector, immediate): Floating-point move immediate (vector).

FMSUB: Floating-point Fused Multiply-Subtract (scalar).

FMUL (by element): Floating-point Multiply (by element).

FMUL (scalar): Floating-point Multiply (scalar).

FMUL (vector): Floating-point Multiply (vector).

FMULX: Floating-point Multiply extended.

FMULX (by element): Floating-point Multiply extended (by element).

FNEG (scalar): Floating-point Negate (scalar).

FNEG (vector): Floating-point Negate (vector).

FNMADD: Floating-point Negated fused Multiply-Add (scalar).

FNMSUB: Floating-point Negated fused Multiply-Subtract (scalar).

FNMUL (scalar): Floating-point Multiply-Negate (scalar).

FRECPE: Floating-point Reciprocal Estimate.

FRECPS: Floating-point Reciprocal Step.

FRECPX: Floating-point Reciprocal exponent (scalar).

FRINT32X (scalar): Floating-point Round to 32-bit Integer, using current rounding mode (scalar).

FRINT32X (vector): Floating-point Round to 32-bit Integer, using current rounding mode (vector).

FRINT32Z (scalar): Floating-point Round to 32-bit Integer toward Zero (scalar).

FRINT32Z (vector): Floating-point Round to 32-bit Integer toward Zero (vector).

FRINT64X (scalar): Floating-point Round to 64-bit Integer, using current rounding mode (scalar).

FRINT64X (vector): Floating-point Round to 64-bit Integer, using current rounding mode (vector).

FRINT64Z (scalar): Floating-point Round to 64-bit Integer toward Zero (scalar).

FRINT64Z (vector): Floating-point Round to 64-bit Integer toward Zero (vector).

FRINTA (scalar): Floating-point Round to Integral, to nearest with ties to Away (scalar).

FRINTA (vector): Floating-point Round to Integral, to nearest with ties to Away (vector).

FRINTI (scalar): Floating-point Round to Integral, using current rounding mode (scalar).

FRINTI (vector): Floating-point Round to Integral, using current rounding mode (vector).

FRINTM (scalar): Floating-point Round to Integral, toward Minus infinity (scalar).

FRINTM (vector): Floating-point Round to Integral, toward Minus infinity (vector).

FRINTN (scalar): Floating-point Round to Integral, to nearest with ties to even (scalar).

FRINTN (vector): Floating-point Round to Integral, to nearest with ties to even (vector).

FRINTP (scalar): Floating-point Round to Integral, toward Plus infinity (scalar).

FRINTP (vector): Floating-point Round to Integral, toward Plus infinity (vector).

FRINTX (scalar): Floating-point Round to Integral exact, using current rounding mode (scalar).

FRINTX (vector): Floating-point Round to Integral exact, using current rounding mode (vector).

FRINTZ (scalar): Floating-point Round to Integral, toward Zero (scalar).

FRINTZ (vector): Floating-point Round to Integral, toward Zero (vector).

FRSQRTE: Floating-point Reciprocal Square Root Estimate.

FRSQRTS: Floating-point Reciprocal Square Root Step.

FSQRT (scalar): Floating-point Square Root (scalar).

FSQRT (vector): Floating-point Square Root (vector).

FSUB (scalar): Floating-point Subtract (scalar).

FSUB (vector): Floating-point Subtract (vector).

INS (element): Insert vector element from another vector element.

INS (general): Insert vector element from general-purpose register.

LD1 (multiple structures): Load multiple single-element structures to one, two, three, or four registers.

LD1 (single structure): Load one single-element structure to one lane of one register.

LD1R: Load one single-element structure and Replicate to all lanes (of one register).

LD2 (multiple structures): Load multiple 2-element structures to two registers.

LD2 (single structure): Load single 2-element structure to one lane of two registers.

LD2R: Load single 2-element structure and Replicate to all lanes of two registers.

LD3 (multiple structures): Load multiple 3-element structures to three registers.

LD3 (single structure): Load single 3-element structure to one lane of three registers).

LD3R: Load single 3-element structure and Replicate to all lanes of three registers.

LD4 (multiple structures): Load multiple 4-element structures to four registers.

LD4 (single structure): Load single 4-element structure to one lane of four registers.

LD4R: Load single 4-element structure and Replicate to all lanes of four registers.

LDNP (SIMD&FP): Load Pair of SIMD&FP registers, with Non-temporal hint.

LDP (SIMD&FP): Load Pair of SIMD&FP registers.

LDR (immediate, SIMD&FP): Load SIMD&FP Register (immediate offset).

LDR (literal, SIMD&FP): Load SIMD&FP Register (PC-relative literal).

LDR (register, SIMD&FP): Load SIMD&FP Register (register offset).

LDUR (SIMD&FP): Load SIMD&FP Register (unscaled offset).

MLA (by element): Multiply-Add to accumulator (vector, by element).

MLA (vector): Multiply-Add to accumulator (vector).

MLS (by element): Multiply-Subtract from accumulator (vector, by element).

MLS (vector): Multiply-Subtract from accumulator (vector).

MOV (element): Move vector element to another vector element: an alias of INS (element).

MOV (from general): Move general-purpose register to a vector element: an alias of INS (general).

MOV (scalar): Move vector element to scalar: an alias of DUP (element).

MOV (to general): Move vector element to general-purpose register: an alias of UMOV.

MOV (vector): Move vector: an alias of ORR (vector, register).

MOVI: Move Immediate (vector).

MUL (by element): Multiply (vector, by element).

MUL (vector): Multiply (vector).

MVN: Bitwise NOT (vector): an alias of NOT.

MVNI: Move inverted Immediate (vector).

NEG (vector): Negate (vector).

NOT: Bitwise NOT (vector).

ORN (vector): Bitwise inclusive OR NOT (vector).

ORR (vector, immediate): Bitwise inclusive OR (vector, immediate).

ORR (vector, register): Bitwise inclusive OR (vector, register).

PMUL: Polynomial Multiply.

PMULL, PMULL2: Polynomial Multiply Long.

RADDHN, RADDHN2: Rounding Add returning High Narrow.

RAX1: Rotate and Exclusive OR.

RBIT (vector): Reverse Bit order (vector).

REV16 (vector): Reverse elements in 16-bit halfwords (vector).

REV32 (vector): Reverse elements in 32-bit words (vector).

REV64: Reverse elements in 64-bit doublewords (vector).

RSHRN, RSHRN2: Rounding Shift Right Narrow (immediate).

RSUBHN, RSUBHN2: Rounding Subtract returning High Narrow.

SABA: Signed Absolute difference and Accumulate.

SABAL, SABAL2: Signed Absolute difference and Accumulate Long.

SABD: Signed Absolute Difference.

SABDL, SABDL2: Signed Absolute Difference Long.

SADALP: Signed Add and Accumulate Long Pairwise.

SADDL, SADDL2: Signed Add Long (vector).

SADDLP: Signed Add Long Pairwise.

SADDLV: Signed Add Long across Vector.

SADDW, SADDW2: Signed Add Wide.

SCVTF (scalar, fixed-point): Signed fixed-point Convert to Floating-point (scalar).

SCVTF (scalar, integer): Signed integer Convert to Floating-point (scalar).

SCVTF (vector, fixed-point): Signed fixed-point Convert to Floating-point (vector).

SCVTF (vector, integer): Signed integer Convert to Floating-point (vector).

SDOT (by element): Dot Product signed arithmetic (vector, by element).

SDOT (vector): Dot Product signed arithmetic (vector).

SHA1C: SHA1 hash update (choose).

SHA1H: SHA1 fixed rotate.

SHA1M: SHA1 hash update (majority).

SHA1P: SHA1 hash update (parity).

SHA1SU0: SHA1 schedule update 0.

SHA1SU1: SHA1 schedule update 1.

SHA256H: SHA256 hash update (part 1).

SHA256H2: SHA256 hash update (part 2).

SHA256SU0: SHA256 schedule update 0.

SHA256SU1: SHA256 schedule update 1.

SHA512H: SHA512 Hash update part 1.

SHA512H2: SHA512 Hash update part 2.

SHA512SU0: SHA512 Schedule Update 0.

SHA512SU1: SHA512 Schedule Update 1.

SHADD: Signed Halving Add.

SHL: Shift Left (immediate).

SHLL, SHLL2: Shift Left Long (by element size).

SHRN, SHRN2: Shift Right Narrow (immediate).

SHSUB: Signed Halving Subtract.

SLI: Shift Left and Insert (immediate).

SM3PARTW1: SM3PARTW1.

SM3PARTW2: SM3PARTW2.

SM3SS1: SM3SS1.

SM3TT1A: SM3TT1A.

SM3TT1B: SM3TT1B.

SM3TT2A: SM3TT2A.

SM3TT2B: SM3TT2B.

SM4E: SM4 Encode.

SM4EKEY: SM4 Key.

SMAX: Signed Maximum (vector).

SMAXP: Signed Maximum Pairwise.

SMAXV: Signed Maximum across Vector.

SMIN: Signed Minimum (vector).

SMINP: Signed Minimum Pairwise.

SMINV: Signed Minimum across Vector.

SMLAL, SMLAL2 (by element): Signed Multiply-Add Long (vector, by element).

SMLAL, SMLAL2 (vector): Signed Multiply-Add Long (vector).

SMLSL, SMLSL2 (by element): Signed Multiply-Subtract Long (vector, by element).

SMLSL, SMLSL2 (vector): Signed Multiply-Subtract Long (vector).

SMOV: Signed Move vector element to general-purpose register.

SMULL, SMULL2 (by element): Signed Multiply Long (vector, by element).

SMULL, SMULL2 (vector): Signed Multiply Long (vector).

SQABS: Signed saturating Absolute value.

SQADD: Signed saturating Add.

SQDMLAL, SQDMLAL2 (by element): Signed saturating Doubling Multiply-Add Long (by element).

SQDMLAL, SQDMLAL2 (vector): Signed saturating Doubling Multiply-Add Long.

SQDMLSL, SQDMLSL2 (by element): Signed saturating Doubling Multiply-Subtract Long (by element).

SQDMLSL, SQDMLSL2 (vector): Signed saturating Doubling Multiply-Subtract Long.

SQDMULH (by element): Signed saturating Doubling Multiply returning High half (by element).

SQDMULH (vector): Signed saturating Doubling Multiply returning High half.

SQDMULL, SQDMULL2 (by element): Signed saturating Doubling Multiply Long (by element).

SQDMULL, SQDMULL2 (vector): Signed saturating Doubling Multiply Long.

SQNEG: Signed saturating Negate.

SQRDMLAH (by element): Signed Saturating Rounding Doubling Multiply Accumulate returning High Half (by element).

SQRDMLAH (vector): Signed Saturating Rounding Doubling Multiply Accumulate returning High Half (vector).

SQRDMLSH (by element): Signed Saturating Rounding Doubling Multiply Subtract returning High Half (by element).

SQRDMLSH (vector): Signed Saturating Rounding Doubling Multiply Subtract returning High Half (vector).

SQRDMULH (by element): Signed saturating Rounding Doubling Multiply returning High half (by element).

SQRDMULH (vector): Signed saturating Rounding Doubling Multiply returning High half.

SQRSHL: Signed saturating Rounding Shift Left (register).

SQRSHRN, SQRSHRN2: Signed saturating Rounded Shift Right Narrow (immediate).

SQRSHRUN, SQRSHRUN2: Signed saturating Rounded Shift Right Unsigned Narrow (immediate).

SQSHL (immediate): Signed saturating Shift Left (immediate).

SQSHL (register): Signed saturating Shift Left (register).

SQSHLU: Signed saturating Shift Left Unsigned (immediate).

SQSHRN, SQSHRN2: Signed saturating Shift Right Narrow (immediate).

SQSHRUN, SQSHRUN2: Signed saturating Shift Right Unsigned Narrow (immediate).

SQSUB: Signed saturating Subtract.

SQXTN, SQXTN2: Signed saturating extract Narrow.

SQXTUN, SQXTUN2: Signed saturating extract Unsigned Narrow.

SRHADD: Signed Rounding Halving Add.

SRI: Shift Right and Insert (immediate).

SRSHL: Signed Rounding Shift Left (register).

SRSHR: Signed Rounding Shift Right (immediate).

SRSRA: Signed Rounding Shift Right and Accumulate (immediate).

SSHL: Signed Shift Left (register).

SSHLL, SSHLL2: Signed Shift Left Long (immediate).

SSHR: Signed Shift Right (immediate).

SSRA: Signed Shift Right and Accumulate (immediate).

SSUBL, SSUBL2: Signed Subtract Long.

SSUBW, SSUBW2: Signed Subtract Wide.

ST1 (multiple structures): Store multiple single-element structures from one, two, three, or four registers.

ST1 (single structure): Store a single-element structure from one lane of one register.

ST2 (multiple structures): Store multiple 2-element structures from two registers.

ST2 (single structure): Store single 2-element structure from one lane of two registers.

ST3 (multiple structures): Store multiple 3-element structures from three registers.

ST3 (single structure): Store single 3-element structure from one lane of three registers.

ST4 (multiple structures): Store multiple 4-element structures from four registers.

ST4 (single structure): Store single 4-element structure from one lane of four registers.

STNP (SIMD&FP): Store Pair of SIMD&FP registers, with Non-temporal hint.

STP (SIMD&FP): Store Pair of SIMD&FP registers.

STR (immediate, SIMD&FP): Store SIMD&FP register (immediate offset).

STR (register, SIMD&FP): Store SIMD&FP register (register offset).

STUR (SIMD&FP): Store SIMD&FP register (unscaled offset).

SUB (vector): Subtract (vector).

SUBHN, SUBHN2: Subtract returning High Narrow.

SUQADD: Signed saturating Accumulate of Unsigned value.

SXTL, SXTL2: Signed extend Long: an alias of SSHLL, SSHLL2.

TBL: Table vector Lookup.

TBX: Table vector lookup extension.

TRN1: Transpose vectors (primary).

TRN2: Transpose vectors (secondary).

UABA: Unsigned Absolute difference and Accumulate.

UABAL, UABAL2: Unsigned Absolute difference and Accumulate Long.

UABD: Unsigned Absolute Difference (vector).

UABDL, UABDL2: Unsigned Absolute Difference Long.

UADALP: Unsigned Add and Accumulate Long Pairwise.

UADDL, UADDL2: Unsigned Add Long (vector).

UADDLP: Unsigned Add Long Pairwise.

UADDLV: Unsigned sum Long across Vector.

UADDW, UADDW2: Unsigned Add Wide.

UCVTF (scalar, fixed-point): Unsigned fixed-point Convert to Floating-point (scalar).

UCVTF (scalar, integer): Unsigned integer Convert to Floating-point (scalar).

UCVTF (vector, fixed-point): Unsigned fixed-point Convert to Floating-point (vector).

UCVTF (vector, integer): Unsigned integer Convert to Floating-point (vector).

UDOT (by element): Dot Product unsigned arithmetic (vector, by element).

UDOT (vector): Dot Product unsigned arithmetic (vector).

UHADD: Unsigned Halving Add.

UHSUB: Unsigned Halving Subtract.

UMAX: Unsigned Maximum (vector).

UMAXP: Unsigned Maximum Pairwise.

UMAXV: Unsigned Maximum across Vector.

UMIN: Unsigned Minimum (vector).

UMINP: Unsigned Minimum Pairwise.

UMINV: Unsigned Minimum across Vector.

UMLAL, UMLAL2 (by element): Unsigned Multiply-Add Long (vector, by element).

UMLAL, UMLAL2 (vector): Unsigned Multiply-Add Long (vector).

UMLSL, UMLSL2 (by element): Unsigned Multiply-Subtract Long (vector, by element).

UMLSL, UMLSL2 (vector): Unsigned Multiply-Subtract Long (vector).

UMOV: Unsigned Move vector element to general-purpose register.

UMULL, UMULL2 (by element): Unsigned Multiply Long (vector, by element).

UMULL, UMULL2 (vector): Unsigned Multiply long (vector).

UQADD: Unsigned saturating Add.

UQRSHL: Unsigned saturating Rounding Shift Left (register).

UQRSHRN, UQRSHRN2: Unsigned saturating Rounded Shift Right Narrow (immediate).

UQSHL (immediate): Unsigned saturating Shift Left (immediate).

UQSHL (register): Unsigned saturating Shift Left (register).

UQSHRN, UQSHRN2: Unsigned saturating Shift Right Narrow (immediate).

UQSUB: Unsigned saturating Subtract.

UQXTN, UQXTN2: Unsigned saturating extract Narrow.

URECPE: Unsigned Reciprocal Estimate.

URHADD: Unsigned Rounding Halving Add.

URSHL: Unsigned Rounding Shift Left (register).

URSHR: Unsigned Rounding Shift Right (immediate).

URSQRTE: Unsigned Reciprocal Square Root Estimate.

URSRA: Unsigned Rounding Shift Right and Accumulate (immediate).

USHL: Unsigned Shift Left (register).

USHLL, USHLL2: Unsigned Shift Left Long (immediate).

USHR: Unsigned Shift Right (immediate).

USQADD: Unsigned saturating Accumulate of Signed value.

USRA: Unsigned Shift Right and Accumulate (immediate).

USUBL, USUBL2: Unsigned Subtract Long.

USUBW, USUBW2: Unsigned Subtract Wide.

UXTL, UXTL2: Unsigned extend Long: an alias of USHLL, USHLL2.

UZP1: Unzip vectors (primary).

UZP2: Unzip vectors (secondary).

XAR: Exclusive OR and Rotate.

XTN, XTN2: Extract Narrow.

ZIP1: Zip vectors (primary).

ZIP2: Zip vectors (secondary).

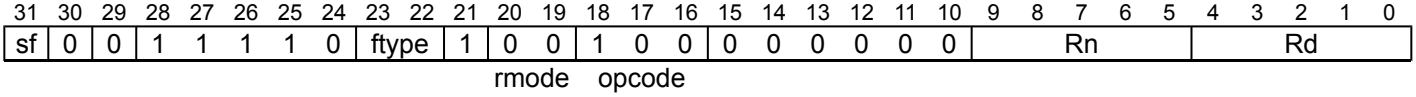
(old) htmldiff from- (new)

FCVTAS (scalar)

Floating-point Convert to Signed integer, rounding to nearest with ties to Away (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit signed integer using the Round to Nearest with Ties to Away rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTAS <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTAS <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTAS <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTAS <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTAS <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTAS <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

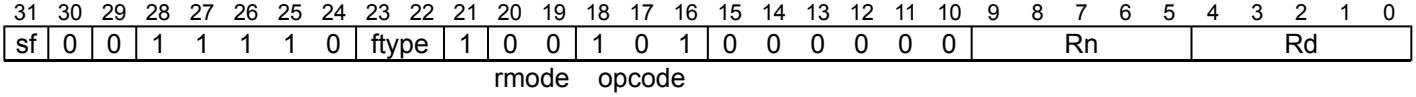
(old) htmldiff from- (new)

FCVTAU (scalar)

Floating-point Convert to Unsigned integer, rounding to nearest with ties to Away (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit unsigned integer using the Round to Nearest with Ties to Away rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTAU <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTAU <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTAU <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTAU <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTAU <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTAU <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

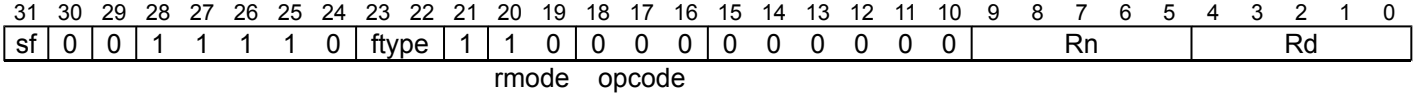
(old) htmldiff from- (new)

FCVTMS (scalar)

Floating-point Convert to Signed integer, rounding toward Minus infinity (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit signed integer using the Round towards Minus Infinity rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTMS <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTMS <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTMS <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTMS <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTMS <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTMS <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

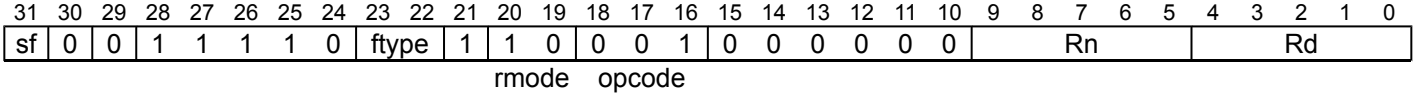
(old) htmldiff from- (new)

FCVTMU (scalar)

Floating-point Convert to Unsigned integer, rounding toward Minus infinity (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit unsigned integer using the Round towards Minus Infinity rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTMU <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTMU <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTMU <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTMU <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTMU <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTMU <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

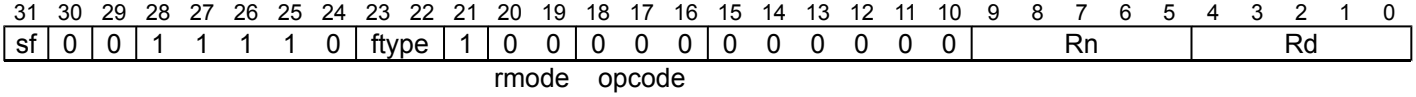
(old) htmldiff from- (new)

FCVTNS (scalar)

Floating-point Convert to Signed integer, rounding to nearest with ties to even (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit signed integer using the Round to Nearest rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTNS <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTNS <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTNS <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTNS <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTNS <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTNS <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

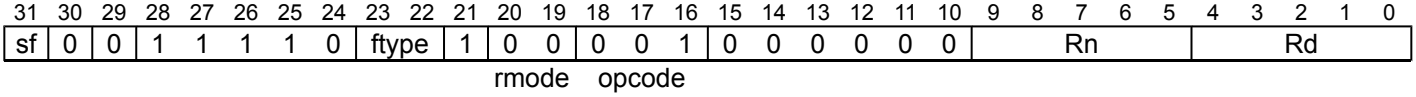
(old) htmldiff from- (new)

FCVTNU (scalar)

Floating-point Convert to Unsigned integer, rounding to nearest with ties to even (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit unsigned integer using the Round to Nearest rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTNU <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTNU <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTNU <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTNU <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTNU <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTNU <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

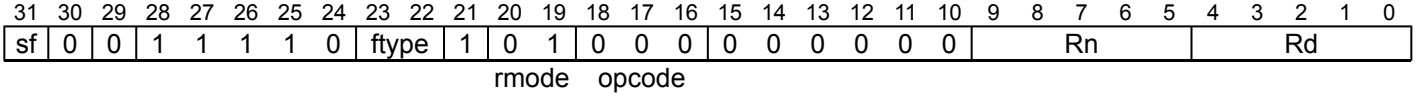
(old) htmldiff from- (new)

FCVTPS (scalar)

Floating-point Convert to Signed integer, rounding toward Plus infinity (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit signed integer using the Round towards Plus Infinity rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTPS <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTPS <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTPS <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTPS <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTPS <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTPS <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

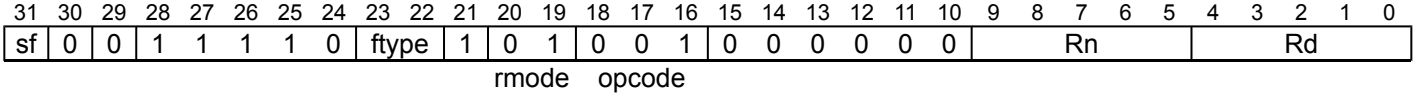
(old) htmldiff from- (new)

FCVTPU (scalar)

Floating-point Convert to Unsigned integer, rounding toward Plus infinity (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit unsigned integer using the Round towards Plus Infinity rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTPU <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTPU <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTPU <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTPU <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTPU <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTPU <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

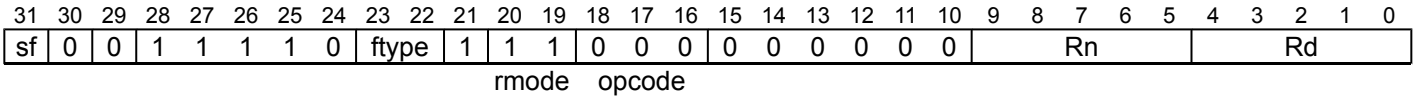
(old) htmldiff from- (new)

FCVTZS (scalar, integer)

Floating-point Convert to Signed integer, rounding toward Zero (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit signed integer using the Round towards Zero rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTZS <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTZS <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTZS <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTZS <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTZS <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTZS <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

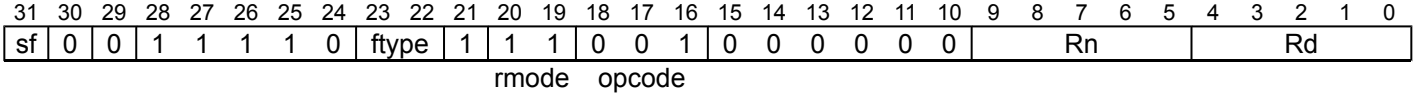
(old) htmldiff from- (new)

FCVTZU (scalar, integer)

Floating-point Convert to Unsigned integer, rounding toward Zero (scalar). This instruction converts the floating-point value in the SIMD&FP source register to a 32-bit or 64-bit unsigned integer using the Round towards Zero rounding mode, and writes the result to the general-purpose destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11)
(Armv8.2)

```
FCVTZU <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11)
(Armv8.2)

```
FCVTZU <Xd>, <Hn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00)

```
FCVTZU <Wd>, <Sn>
```

Single-precision to 64-bit (sf == 1 && ftype == 00)

```
FCVTZU <Xd>, <Sn>
```

Double-precision to 32-bit (sf == 0 && ftype == 01)

```
FCVTZU <Wd>, <Dn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01)

```
FCVTZU <Xd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Xd>	Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Hn>	Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

(old) htmldiff from- (new)

FJCVTZS

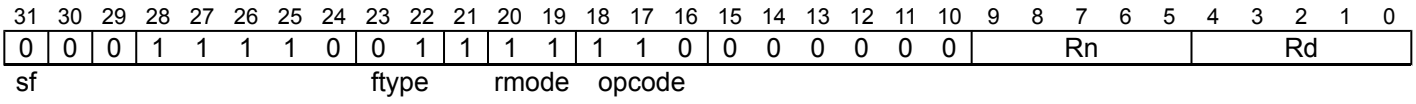
Floating-point Javascript Convert to Signed fixed-point, rounding toward Zero. This instruction converts the double-precision floating-point value in the SIMD&FP source register to a 32-bit signed integer using the Round towards Zero rounding mode, and writes the result to the general-purpose destination register. If the result is too large to be accommodated as a signed 32-bit integer, then the result is the integer modulo 2^{32}, as held in a 32-bit signed integer.

This instruction can generate a floating-point exception. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR* or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.

Double-precision to 32-bit

(Armv8.3)



Double-precision to 32-bit

```
FJCVTZS <Wd>, <Dn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Dn>	Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

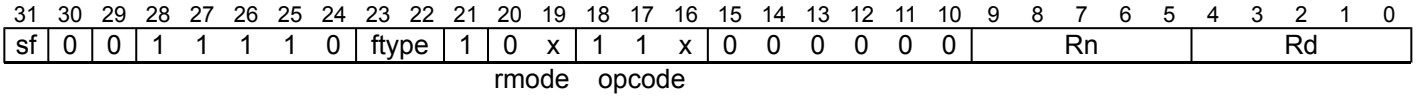
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

FMOV (general)

Floating-point Move to or from general-purpose register without conversion. This instruction transfers the contents of a SIMD&FP register to a general-purpose register, or the contents of a general-purpose register to a SIMD&FP register.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



Half-precision to 32-bit (sf == 0 && ftype == 11 && rmode == 00 && opcode == 110)
(Armv8.2)

```
FMOV <Wd>, <Hn>
```

Half-precision to 64-bit (sf == 1 && ftype == 11 && rmode == 00 && opcode == 110)
(Armv8.2)

```
FMOV <Xd>, <Hn>
```

32-bit to half-precision (sf == 0 && ftype == 11 && rmode == 00 && opcode == 111)
(Armv8.2)

```
FMOV <Hd>, <Wn>
```

32-bit to single-precision (sf == 0 && ftype == 00 && rmode == 00 && opcode == 111)

```
FMOV <Sd>, <Wn>
```

Single-precision to 32-bit (sf == 0 && ftype == 00 && rmode == 00 && opcode == 110)

```
FMOV <Wd>, <Sn>
```

64-bit to half-precision (sf == 1 && ftype == 11 && rmode == 00 && opcode == 111)
(Armv8.2)

```
FMOV <Hd>, <Xn>
```

64-bit to double-precision (sf == 1 && ftype == 01 && rmode == 00 && opcode == 111)

```
FMOV <Dd>, <Xn>
```

64-bit to top half of 128-bit (sf == 1 && ftype == 10 && rmode == 01 && opcode == 111)

```
FMOV <Vd>.D[1], <Xn>
```

Double-precision to 64-bit (sf == 1 && ftype == 01 && rmode == 00 && opcode == 110)

```
FMOV <Xd>, <Dn>
```

Top half of 128-bit to 64-bit (sf == 1 && ftype == 10 && rmode == 01 && opcode == 110)

```
FMOV <Xd>, <Vn>.D[1]
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Dd>	Is the 64-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Hd>	Is the 16-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Sd>	Is the 32-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Wn>	Is the 32-bit name of the general-purpose source register, encoded in the "Rn" field.
<Vd>	Is the name of the SIMD&FP destination register, encoded in the "Rd" field.
<Xn>	Is the 64-bit name of the general-purpose source register, encoded in the "Rn" field.
<Wd>	Is the 32-bit name of the general-purpose destination register, encoded in the "Rd" field.
<Sn>	Is the 32-bit name of the SIMD&FP source register, encoded in the "Rn" field.

<Xd> Is the 64-bit name of the general-purpose destination register, encoded in the "Rd" field.

<Vn> Is the name of the SIMD&FP source register, encoded in the "Rn" field.

<Hn> Is the 16-bit name of the SIMD&FP source register, encoded in the "Rn" field.

<Dn> Is the 64-bit name of the SIMD&FP source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

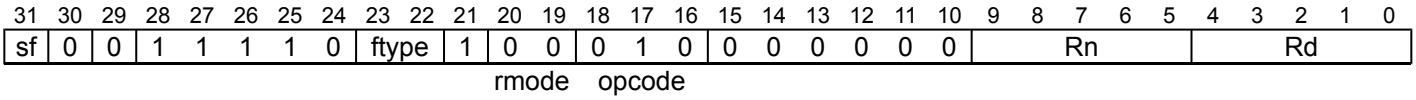
(old) htmldiff from- (new)

SCVTF (scalar, integer)

Signed integer Convert to Floating-point (scalar). This instruction converts the signed integer value in the general-purpose source register to a floating-point value using the rounding mode that is specified by the *FPCR*, and writes the result to the SIMD&FP destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



32-bit to half-precision (sf == 0 && ftype == 11)
(Armv8.2)

```
SCVTF <Hd>, <Wn>
```

32-bit to single-precision (sf == 0 && ftype == 00)

```
SCVTF <Sd>, <Wn>
```

32-bit to double-precision (sf == 0 && ftype == 01)

```
SCVTF <Dd>, <Wn>
```

64-bit to half-precision (sf == 1 && ftype == 11)
(Armv8.2)

```
SCVTF <Hd>, <Xn>
```

64-bit to single-precision (sf == 1 && ftype == 00)

```
SCVTF <Sd>, <Xn>
```

64-bit to double-precision (sf == 1 && ftype == 01)

```
SCVTF <Dd>, <Xn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Dd>	Is the 64-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Hd>	Is the 16-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Sd>	Is the 32-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Xn>	Is the 64-bit name of the general-purpose source register, encoded in the "Rn" field.
<Wn>	Is the 32-bit name of the general-purpose source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

SM3TT2A

SM3TT2A takes three 128-bit vectors from three source SIMD&FP register and a 2-bit immediate index value, and returns a 128-bit result in the destination SIMD&FP register. It performs a three-way exclusive OR of the three 32-bit fields held in the upper three elements of the first source vector, and adds the resulting 32-bit value and the following three other 32-bit values:

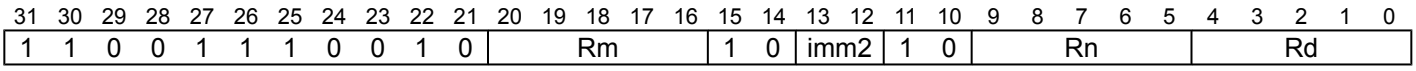
- The bottom 32-bit element of the first source vector, Vd, that was used for the three-way exclusive OR.
- The 32-bit element held in the top 32 bits of the second source vector, Vn.
- A 32-bit element indexed out of the third source vector, Vm.

A three-way exclusive OR is performed of the result of this addition, the result of the addition rotated left by 9, and the result of the addition rotated left by 17. The result of this exclusive OR is returned as the top element of the returned result. The other elements of this result are taken from elements of the first source vector, with the element returned in bits<63:32> being rotated left by 19.

This instruction is implemented only when *ARMv8.2-SM* is implemented.

Advanced SIMD

(Armv8.2)



Advanced SIMD

```
SM3TT2A <Vd>.4S, <Vn>.4S, <Vm>.S[<imm2>]

if !HaveSM3Ext() then UNDEFINED;
integer d = UInt(Rd);
integer n = UInt(Rn);
integer m = UInt(Rm);

integer i = UInt(imm2);
```

Assembler Symbols

<Vd>	Is the name of the SIMD&FP source and destination register, encoded in the "Rd" field.
<Vn>	Is the name of the second SIMD&FP source register, encoded in the "Rn" field.
<Vm>	Is the name of the third SIMD&FP source register, encoded in the "Rm" field.
<imm2>	Is a 32-bit element indexed out of <Vm>, encoded in "imm2".

Operation

```
AArch64.CheckFPAdvSIMDEnabled();

bits(128) Vm = V[m];
bits(128) Vn = V[n];
bits(128) Vd = V[d];
bits(32) Wj;
bits(128) result;
bits(32) TT2;
~~bits(32) TT1;~~

Wj = Elem[Vm,i,32];
TT2 = Vd<63:32> EOR (Vd<127:96> EOR Vd<95:64>);
TT2 = (TT2 + Vd<31:0> + Vn<127:96> + Wj)<31:0>;

result<31:0> = Vd<63:32>;
result<63:32> = ROL(Vd<95:64>,19);
result<95:64> = Vd<127:96>;
result<127:96> = TT2 EOR ROL(TT2,9) EOR ROL(TT2,17);
V[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

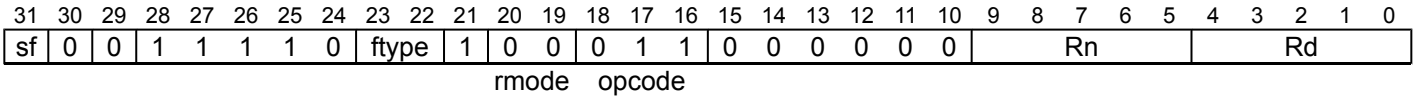
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UCVTF (scalar, integer)

Unsigned integer Convert to Floating-point (scalar). This instruction converts the unsigned integer value in the general-purpose source register to a floating-point value using the rounding mode that is specified by the *FPCR*, and writes the result to the SIMD&FP destination register.

A floating-point exception can be generated by this instruction. Depending on the settings in *FPCR*, the exception results in either a flag being set in *FPSR*, or a synchronous exception being generated. For more information, see *Floating-point exception traps*.

Depending on the settings in the *CPACR_EL1*, *CPTR_EL2*, and *CPTR_EL3* registers, and the current Security state and Exception level, an attempt to execute the instruction might be trapped.



32-bit to half-precision (sf == 0 && ftype == 11)
(Armv8.2)

```
UCVTF <Hd>, <Wn>
```

32-bit to single-precision (sf == 0 && ftype == 00)

```
UCVTF <Sd>, <Wn>
```

32-bit to double-precision (sf == 0 && ftype == 01)

```
UCVTF <Dd>, <Wn>
```

64-bit to half-precision (sf == 1 && ftype == 11)
(Armv8.2)

```
UCVTF <Hd>, <Xn>
```

64-bit to single-precision (sf == 1 && ftype == 00)

```
UCVTF <Sd>, <Xn>
```

64-bit to double-precision (sf == 1 && ftype == 01)

```
UCVTF <Dd>, <Xn>
```

```
integer d = UInt(Rd);
integer n = UInt(Rn);

integer intsize = if sf == '1' then 64 else 32;
integer fltsize;
FPConvOp op;
FPRounding rounding;
boolean unsigned;
integer part;

case ftype of
    when '00'
        fltsize = 32;
    when '01'
        fltsize = 64;
    when '10'
        if opcode<2:1>:rmode != '11 01' then UNDEFINED;
        fltsize = 128;
    when '11'
        if HaveFP16Ext() then
            fltsize = 16;
        else
            UNDEFINED;

case opcode<2:1>:rmode of
    when '00 xx'        // FCVT[NPMZ][US]
        rounding = FPDecodeRounding(rmode);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '01 00'        // [US]CVTF
        rounding = FPRoundingMode(FPCR);
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_ItoF;
    when '10 00'        // FCVTA[US]
        rounding = FPRounding_TIEAWAY;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI;
    when '11 00'        // FMOV
        if fltsize != 16 && fltsize != intsize then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 0;
    when '11 01'        // FMOV D[1]
        if intsize != 64 || fltsize != 128 then UNDEFINED;
        op = if opcode<0> == '1' then FPConvOp_MOV_ItoF else FPConvOp_MOV_FtoI;
        part = 1;
        fltsize = 64;  // size of D[1] is 64
    when '11 11'       // FJCVTZS
        if !HaveFJCVTZSExt() then UNDEFINED;
        rounding = FPRounding_ZERO;
        unsigned = (opcode<0> == '1');
        op = FPConvOp_CVT_FtoI_JS;
    otherwise
        UNDEFINED;
```

Assembler Symbols

<Dd>	Is the 64-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Hd>	Is the 16-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Sd>	Is the 32-bit name of the SIMD&FP destination register, encoded in the "Rd" field.
<Xn>	Is the 64-bit name of the general-purpose source register, encoded in the "Rn" field.
<Wn>	Is the 32-bit name of the general-purpose source register, encoded in the "Rn" field.

Operation

```
CheckFPAdvSIMDEnabled64();

bits(fltsize) fltval;
bits(intsize) intval;

case op of
    when FPConvOp_CVT_FtoI
        fltval = V[n];
        intval = FPToFixed(fltval, 0, unsigned, FPCR, rounding);
        X[d] = intval;
    when FPConvOp_CVT_ItoF
        intval = X[n];
        fltval = FixedToFP(intval, 0, unsigned, FPCR, rounding);
        V[d] = fltval;
    when FPConvOp_MOV_FtoI
        fltval = Vpart[n,part];
        intval = ZeroExtend(fltval, intsize);
        X[d] = intval;
    when FPConvOp_MOV_ItoF
        intval = X[n];
        fltval = intval<fltsize-1:0>;
        Vpart[d,part] = fltval;
    when FPConvOp_CVT_FtoI_JS
        bit Z;
        fltval =fltval = V[n];
        (intval, Z) =        intval = FPToFixedJS(fltval, FPCR, TRUE);
        PSTATE.<N,Z,C,V> = '0':Z:'00';(fltval, FPCR, TRUE);
        X[d] = intval;[d] =ZeroExtend(intval<31:0>, 64);
```

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

A64 -- SVE Instructions (alphabetic order)

ABS: Absolute value (predicated).

ADCLB: Add with carry long (bottom).

ADCLT: Add with carry long (top).

ADD (immediate): Add immediate (unpredicated).

ADD (vectors, predicated): Add vectors (predicated).

ADD (vectors, unpredicated): Add vectors (unpredicated).

ADDHNB: Add narrow high part (bottom).

ADDHNT: Add narrow high part (top).

ADDP: Add pairwise.

ADDPL: Add multiple of predicate register size to scalar register.

ADDVL: Add multiple of vector register size to scalar register.

ADR: Compute vector address.

AESD: AES single round decryption.

AESE: AES single round encryption.

AESIMC: AES inverse mix columns.

AESMC: AES mix columns.

AND (immediate): Bitwise AND with immediate (unpredicated).

AND (vectors, predicated): Bitwise AND vectors (predicated).

AND (vectors, unpredicated): Bitwise AND vectors (unpredicated).

AND, ANDS (predicates): Bitwise AND predicates.

ANDV: Bitwise AND reduction to scalar.

ASR (immediate, predicated): Arithmetic shift right by immediate (predicated).

ASR (immediate, unpredicated): Arithmetic shift right by immediate (unpredicated).

ASR (vectors): Arithmetic shift right by vector (predicated).

ASR (wide elements, predicated): Arithmetic shift right by 64-bit wide elements (predicated).

ASR (wide elements, unpredicated): Arithmetic shift right by 64-bit wide elements (unpredicated).

ASRD: Arithmetic shift right for divide by immediate (predicated).

ASRR: Reversed arithmetic shift right by vector (predicated).

BCAX: Bitwise clear and exclusive OR.

BDEP: Scatter lower bits into positions selected by bitmask.

BEXT: Gather lower bits from positions selected by bitmask.

BGRP: Group bits to right or left as selected by bitmask.

BIC (immediate): Bitwise clear bits using immediate (unpredicated): an alias of AND (immediate).

BIC (vectors, predicated): Bitwise clear vectors (predicated).

BIC (vectors, unpredicated): Bitwise clear vectors (unpredicated).

BIC, BICS (predicates): Bitwise clear predicates.

BRKA, BRKAS: Break after first true condition.

BRKB, BRKBS: Break before first true condition.

BRKN, BRKNS: Propagate break to next partition.

BRKPA, BRKPAS: Break after first true condition, propagating from previous partition.

BRKPB, BRKPBS: Break before first true condition, propagating from previous partition.

BSL: Bitwise select.

BSL1N: Bitwise select with first input inverted.

BSL2N: Bitwise select with second input inverted.

CADD: Complex integer add with rotate.

CDOT (indexed): Complex integer dot product (indexed).

CDOT (vectors): Complex integer dot product.

CLASTA (scalar): Conditionally extract element after last to general-purpose register.

CLASTA (SIMD&FP scalar): Conditionally extract element after last to SIMD&FP scalar register.

CLASTA (vectors): Conditionally extract element after last to vector register.

CLASTB (scalar): Conditionally extract last element to general-purpose register.

CLASTB (SIMD&FP scalar): Conditionally extract last element to SIMD&FP scalar register.

CLASTB (vectors): Conditionally extract last element to vector register.

CLS: Count leading sign bits (predicated).

CLZ: Count leading zero bits (predicated).

CMLA (indexed): Complex integer multiply-add with rotate (indexed).

CMLA (vectors): Complex integer multiply-add with rotate.

CMP<cc> (immediate): Compare vector to immediate.

CMP<cc> (vectors): Compare vectors.

CMP<cc> (wide elements): Compare vector to 64-bit wide elements.

CMPLE (vectors): Compare signed less than or equal to vector, setting the condition flags: an alias of CMP<cc> (vectors).

CMPLO (vectors): Compare unsigned lower than vector, setting the condition flags: an alias of CMP<cc> (vectors).

CMPLS (vectors): Compare unsigned lower or same as vector, setting the condition flags: an alias of CMP<cc> (vectors).

CMPLT (vectors): Compare signed less than vector, setting the condition flags: an alias of CMP<cc> (vectors).

CNOT: Logically invert boolean condition in vector (predicated).

CNT: Count non-zero bits (predicated).

CNTB, CNTD, CNTH, CNTW: Set scalar to multiple of predicate constraint element count.

CNTP: Set scalar to count~~active~~ of~~predicate~~ true~~element~~ predicate elements.~~count.~~

COMPACT: Shuffle active elements of vector to the right and fill with zero.

CPY (immediate, merging): Copy signed integer immediate to vector elements (merging~~predicated~~).

CPY (immediate, zeroing): Copy signed integer immediate to vector elements (zeroing).

CPY (scalar): Copy general-purpose register to vector elements (predicated).

CPY (SIMD&FP scalar): Copy SIMD&FP scalar register to vector elements (predicated).

CTERMEQ, CTERMNE: Compare and terminate loop.

DECB, DECD, DECH, DECW (scalar): Decrement scalar by multiple of predicate constraint element count.

DECD, DECH, DECW (vector): Decrement vector by multiple of predicate constraint element count.

DECP (scalar): Decrement scalar by count~~active~~ of~~predicate~~ true~~element~~ predicate elements.~~count.~~

DECP (vector): Decrement vector by count~~active~~ of~~predicate~~ true~~element~~ predicate elements.~~count.~~

DUP (immediate): Broadcast signed immediate to vector elements (unpredicated).

DUP (indexed): Broadcast indexed element to vector (unpredicated).

DUP (scalar): Broadcast general-purpose register to vector elements (unpredicated).

DUPM: Broadcast logical bitmask immediate to vector (unpredicated).

EON: Bitwise exclusive OR with inverted immediate (unpredicated): an alias of EOR (immediate).

EOR (immediate): Bitwise exclusive OR with immediate (unpredicated).

EOR (vectors, predicated): Bitwise exclusive OR vectors (predicated).

EOR (vectors, unpredicated): Bitwise exclusive OR vectors (unpredicated).

EOR, EORS (predicates): Bitwise exclusive OR predicates.

EOR3: Bitwise exclusive OR of three vectors.

EORBT: Interleaving exclusive OR (bottom, top).

EORTB: Interleaving exclusive OR (top, bottom).

EORV: Bitwise exclusive OR reduction to scalar.

EXT: Extract vector from pair of vectors.

FABD: Floating-point absolute difference (predicated).

FABS: Floating-point absolute value (predicated).

FAC<cc>: Floating-point absolute compare vectors.

FACLE: Floating-point absolute compare less than or equal: an alias of FAC<cc>.

FACLT: Floating-point absolute compare less than: an alias of FAC<cc>.

FADD (immediate): Floating-point add immediate (predicated).

FADD (vectors, predicated): Floating-point add vector (predicated).

FADD (vectors, unpredicated): Floating-point add vector (unpredicated).

FADDA: Floating-point add strictly-ordered reduction, accumulating in scalar.

FADDP: Floating-point add pairwise.

FADDV: Floating-point add recursive reduction to scalar.

FCADD: Floating-point complex add with rotate (predicated).

FCM<cc> (vectors): Floating-point compare vectors.

FCM<cc> (zero): Floating-point compare vector with zero.

FCMLA (indexed): Floating-point complex multiply-add by indexed values with rotate.

FCMLA (vectors): Floating-point complex multiply-add with rotate (predicated).

FCMLE (vectors): Floating-point compare less than or equal to vector: an alias of FCM<cc> (vectors).

FCMLT (vectors): Floating-point compare less than vector: an alias of FCM<cc> (vectors).

FCPY: Copy 8-bit floating-point immediate to vector elements (predicated).

FCVT: Floating-point convert precision (predicated).

FCVTLT: Floating-point up convert long (top, predicated).

FCVTNT: Floating-point down convert and narrow (top, predicated).

FCVTX: Floating-point down convert, rounding to odd (predicated).

FCVTXNT: Floating-point down convert, rounding to odd (top, predicated).

FCVTZS: Floating-point convert to signed integer, rounding toward zero (predicated).

FCVTZU: Floating-point convert to unsigned integer, rounding toward zero (predicated).

FDIV: Floating-point divide by vector (predicated).

FDIVR: Floating-point reversed divide by vector (predicated).

FDUP: Broadcast 8-bit floating-point immediate to vector elements (unpredicated).

FEXPA: Floating-point exponential accelerator.

FLOGB: Floating-point base 2 logarithm as integer.

FMAD: Floating-point fused multiply-add vectors (predicated), writing multiplicand [Zdn = Za + Zdn * Zm].

FMAX (immediate): Floating-point maximum with immediate (predicated).

FMAX (vectors): Floating-point maximum (predicated).

FMAXNM (immediate): Floating-point maximum number with immediate (predicated).

FMAXNM (vectors): Floating-point maximum number (predicated).

FMAXNMP: Floating-point maximum number pairwise.

FMAXNMV: Floating-point maximum number recursive reduction to scalar.

FMAXP: Floating-point maximum pairwise.

FMAXV: Floating-point maximum recursive reduction to scalar.

FMIN (immediate): Floating-point minimum with immediate (predicated).

FMIN (vectors): Floating-point minimum (predicated).

FMINNM (immediate): Floating-point minimum number with immediate (predicated).

FMINNM (vectors): Floating-point minimum number (predicated).

FMINNMP: Floating-point minimum number pairwise.

FMINNMV: Floating-point minimum number recursive reduction to scalar.

FMINP: Floating-point minimum pairwise.

FMINV: Floating-point minimum recursive reduction to scalar.

FMLA (indexed): Floating-point fused multiply-add by indexed elements (Zda = Zda + Zn * Zm[indexed]).

FMLA (vectors): Floating-point fused multiply-add vectors (predicated), writing addend [Zda = Zda + Zn * Zm].

FMLALB (indexed): Half-precision floating-point multiply-add long to single-precision (bottom, indexed).

FMLALB (vectors): Half-precision floating-point multiply-add long to single-precision (bottom).

FMLALT (indexed): Half-precision floating-point multiply-add long to single-precision (top, indexed).

FMLALT (vectors): Half-precision floating-point multiply-add long to single-precision (top).

FMLS (indexed): Floating-point fused multiply-subtract by indexed elements (Zda = Zda + -Zn * Zm[indexed]).

FMLS (vectors): Floating-point fused multiply-subtract vectors (predicated), writing addend [Zda = Zda + -Zn * Zm].

FMLSLB (indexed): Half-precision floating-point multiply-subtract long from single-precision (bottom, indexed).

FMLSLB (vectors): Half-precision floating-point multiply-subtract long from single-precision (bottom).

FMLSLT (indexed): Half-precision floating-point multiply-subtract long from single-precision (top, indexed).

FMLSLT (vectors): Half-precision floating-point multiply-subtract long from single-precision (top).

FMOV (immediate, predicated): Move 8-bit floating-point immediate to vector elements (predicated): an alias of FCPY.

FMOV (immediate, unpredicated): Move 8-bit floating-point immediate to vector elements (unpredicated): an alias of FDUP.

FMOV (zero, predicated): Move floating-point +0.0 to vector elements (predicated): an alias of CPY (immediate, merging).

FMOV (zero, unpredicated): Move floating-point +0.0 to vector elements (unpredicated): an alias of DUP (immediate).

FMSB: Floating-point fused multiply-subtract vectors (predicated), writing multiplicand [Zdn = Za + -Zdn * Zm].

FMUL (immediate): Floating-point multiply by immediate (predicated).

FMUL (indexed): Floating-point multiply by indexed elements.

FMUL (vectors, predicated): Floating-point multiply vectors (predicated).

FMUL (vectors, unpredicated): Floating-point multiply vectors (unpredicated).

FMULX: Floating-point multiply-extended vectors (predicated).

FNEG: Floating-point negate (predicated).

FNMAD: Floating-point negated fused multiply-add vectors (predicated), writing multiplicand [Zdn = -Za + -Zdn * Zm].

FNMLA: Floating-point negated fused multiply-add vectors (predicated), writing addend [Zda = -Zda + -Zn * Zm].

FNMLS: Floating-point negated fused multiply-subtract vectors (predicated), writing addend [Zda = -Zda + Zn * Zm].

FNMSB: Floating-point negated fused multiply-subtract vectors (predicated), writing multiplicand [Zdn = -Za + Zdn * Zm].

FRECPE: Floating-point reciprocal estimate (unpredicated).

FRECPS: Floating-point reciprocal step (unpredicated).

FRECPX: Floating-point reciprocal exponent (predicated).

FRINT<r>: Floating-point round to integral value (predicated).

FRSQRTE: Floating-point reciprocal square root estimate (unpredicated).

FRSQRTS: Floating-point reciprocal square root step (unpredicated).

FSCALE: Floating-point adjust exponent by vector (predicated).

FSQRT: Floating-point square root (predicated).

FSUB (immediate): Floating-point subtract immediate (predicated).

FSUB (vectors, predicated): Floating-point subtract vectors (predicated).

FSUB (vectors, unpredicated): Floating-point subtract vectors (unpredicated).

FSUBR (immediate): Floating-point reversed subtract from immediate (predicated).

FSUBR (vectors): Floating-point reversed subtract vectors (predicated).

FTMAD: Floating-point trigonometric multiply-add coefficient.

FTSMUL: Floating-point trigonometric starting value.

FTSSEL: Floating-point trigonometric select coefficient.

HISTCNT: Count matching elements in vector.

HISTSEG: Count matching elements in vector segments.

INCB, INCD, INCH, INCW (scalar): Increment scalar by multiple of predicate constraint element count.

INCD, INCH, INCW (vector): Increment vector by multiple of predicate constraint element count.

INCP (scalar): Increment scalar by countactive ofpredicate trueelement predicate elements.count.

INCP (vector): Increment vector by countactive ofpredicate trueelement predicate elements.count.

INDEX (immediate, scalar): Create index starting from immediate and incremented by general-purpose register.

INDEX (immediates): Create index starting from and incremented by immediate.

INDEX (scalar, immediate): Create index starting from general-purpose register and incremented by immediate.

INDEX (scalars): Create index starting from and incremented by general-purpose register.

INSR (scalar): Insert general-purpose register in shifted vector.

INSR (SIMD&FP scalar): Insert SIMD&FP scalar register in shifted vector.

LASTA (scalar): Extract element after last to general-purpose register.

LASTA (SIMD&FP scalar): Extract element after last to SIMD&FP scalar register.

LASTB (scalar): Extract last element to general-purpose register.

LASTB (SIMD&FP scalar): Extract last element to SIMD&FP scalar register.

LD1B (scalar plus immediate): Contiguous load unsigned bytes to vector (immediate index).

LD1B (scalar plus scalar): Contiguous load unsigned bytes to vector (scalar index).

LD1B (scalar plus vector): Gather load unsigned bytes to vector (vector index).

LD1B (vector plus immediate): Gather load unsigned bytes to vector (immediate index).

LD1D (scalar plus immediate): Contiguous load doublewords to vector (immediate index).

LD1D (scalar plus scalar): Contiguous load doublewords to vector (scalar index).

LD1D (scalar plus vector): Gather load doublewords to vector (vector index).

LD1D (vector plus immediate): Gather load doublewords to vector (immediate index).

LD1H (scalar plus immediate): Contiguous load unsigned halfwords to vector (immediate index).

LD1H (scalar plus scalar): Contiguous load unsigned halfwords to vector (scalar index).

LD1H (scalar plus vector): Gather load unsigned halfwords to vector (vector index).

LD1H (vector plus immediate): Gather load unsigned halfwords to vector (immediate index).

LD1RB: Load and broadcast unsigned byte to vector.

LD1RD: Load and broadcast doubleword to vector.

LD1RH: Load and broadcast unsigned halfword to vector.

LD1RQB (scalar plus immediate): Contiguous load and replicate sixteen bytes (immediate index).

LD1RQB (scalar plus scalar): Contiguous load and replicate sixteen bytes (scalar index).

LD1RQD (scalar plus immediate): Contiguous load and replicate two doublewords (immediate index).

LD1RQD (scalar plus scalar): Contiguous load and replicate two doublewords (scalar index).

LD1RQH (scalar plus immediate): Contiguous load and replicate eight halfwords (immediate index).

LD1RQH (scalar plus scalar): Contiguous load and replicate eight halfwords (scalar index).

LD1RQW (scalar plus immediate): Contiguous load and replicate four words (immediate index).

LD1RQW (scalar plus scalar): Contiguous load and replicate four words (scalar index).

LD1RSB: Load and broadcast signed byte to vector.

LD1RSH: Load and broadcast signed halfword to vector.

LD1RSW: Load and broadcast signed word to vector.

LD1RW: Load and broadcast unsigned word to vector.

LD1SB (scalar plus immediate): Contiguous load signed bytes to vector (immediate index).

LD1SB (scalar plus scalar): Contiguous load signed bytes to vector (scalar index).

LD1SB (scalar plus vector): Gather load signed bytes to vector (vector index).

LD1SB (vector plus immediate): Gather load signed bytes to vector (immediate index).

LD1SH (scalar plus immediate): Contiguous load signed halfwords to vector (immediate index).

LD1SH (scalar plus scalar): Contiguous load signed halfwords to vector (scalar index).

LD1SH (scalar plus vector): Gather load signed halfwords to vector (vector index).

LD1SH (vector plus immediate): Gather load signed halfwords to vector (immediate index).

LD1SW (scalar plus immediate): Contiguous load signed words to vector (immediate index).

LD1SW (scalar plus scalar): Contiguous load signed words to vector (scalar index).

LD1SW (scalar plus vector): Gather load signed words to vector (vector index).

LD1SW (vector plus immediate): Gather load signed words to vector (immediate index).

LD1W (scalar plus immediate): Contiguous load unsigned words to vector (immediate index).

LD1W (scalar plus scalar): Contiguous load unsigned words to vector (scalar index).

LD1W (scalar plus vector): Gather load unsigned words to vector (vector index).

LD1W (vector plus immediate): Gather load unsigned words to vector (immediate index).

LD2B (scalar plus immediate): Contiguous load two-byte structures to two vectors (immediate index).

LD2B (scalar plus scalar): Contiguous load two-byte structures to two vectors (scalar index).

LD2D (scalar plus immediate): Contiguous load two-doubleword structures to two vectors (immediate index).

LD2D (scalar plus scalar): Contiguous load two-doubleword structures to two vectors (scalar index).

LD2H (scalar plus immediate): Contiguous load two-halfword structures to two vectors (immediate index).

LD2H (scalar plus scalar): Contiguous load two-halfword structures to two vectors (scalar index).

LD2W (scalar plus immediate): Contiguous load two-word structures to two vectors (immediate index).

LD2W (scalar plus scalar): Contiguous load two-word structures to two vectors (scalar index).

LD3B (scalar plus immediate): Contiguous load three-byte structures to three vectors (immediate index).

LD3B (scalar plus scalar): Contiguous load three-byte structures to three vectors (scalar index).

LD3D (scalar plus immediate): Contiguous load three-doubleword structures to three vectors (immediate index).

LD3D (scalar plus scalar): Contiguous load three-doubleword structures to three vectors (scalar index).

LD3H (scalar plus immediate): Contiguous load three-halfword structures to three vectors (immediate index).

LD3H (scalar plus scalar): Contiguous load three-halfword structures to three vectors (scalar index).

LD3W (scalar plus immediate): Contiguous load three-word structures to three vectors (immediate index).

LD3W (scalar plus scalar): Contiguous load three-word structures to three vectors (scalar index).

LD4B (scalar plus immediate): Contiguous load four-byte structures to four vectors (immediate index).

LD4B (scalar plus scalar): Contiguous load four-byte structures to four vectors (scalar index).

LD4D (scalar plus immediate): Contiguous load four-doubleword structures to four vectors (immediate index).

LD4D (scalar plus scalar): Contiguous load four-doubleword structures to four vectors (scalar index).

LD4H (scalar plus immediate): Contiguous load four-halfword structures to four vectors (immediate index).

LD4H (scalar plus scalar): Contiguous load four-halfword structures to four vectors (scalar index).

LD4W (scalar plus immediate): Contiguous load four-word structures to four vectors (immediate index).

LD4W (scalar plus scalar): Contiguous load four-word structures to four vectors (scalar index).

LDFF1B (scalar plus scalar): Contiguous load first-fault unsigned bytes to vector (scalar index).

LDFF1B (scalar plus vector): Gather load first-fault unsigned bytes to vector (vector index).

LDFF1B (vector plus immediate): Gather load first-fault unsigned bytes to vector (immediate index).

LDFF1D (scalar plus scalar): Contiguous load first-fault doublewords to vector (scalar index).

LDFF1D (scalar plus vector): Gather load first-fault doublewords to vector (vector index).

LDFF1D (vector plus immediate): Gather load first-fault doublewords to vector (immediate index).

LDFF1H (scalar plus scalar): Contiguous load first-fault unsigned halfwords to vector (scalar index).

LDFF1H (scalar plus vector): Gather load first-fault unsigned halfwords to vector (vector index).

LDFF1H (vector plus immediate): Gather load first-fault unsigned halfwords to vector (immediate index).

LDFF1SB (scalar plus scalar): Contiguous load first-fault signed bytes to vector (scalar index).

LDFF1SB (scalar plus vector): Gather load first-fault signed bytes to vector (vector index).

LDFF1SB (vector plus immediate): Gather load first-fault signed bytes to vector (immediate index).

LDFF1SH (scalar plus scalar): Contiguous load first-fault signed halfwords to vector (scalar index).

LDFF1SH (scalar plus vector): Gather load first-fault signed halfwords to vector (vector index).

LDFF1SH (vector plus immediate): Gather load first-fault signed halfwords to vector (immediate index).

LDFF1SW (scalar plus scalar): Contiguous load first-fault signed words to vector (scalar index).

LDFF1SW (scalar plus vector): Gather load first-fault signed words to vector (vector index).

LDFF1SW (vector plus immediate): Gather load first-fault signed words to vector (immediate index).

LDFF1W (scalar plus scalar): Contiguous load first-fault unsigned words to vector (scalar index).

LDFF1W (scalar plus vector): Gather load first-fault unsigned words to vector (vector index).

LDFF1W (vector plus immediate): Gather load first-fault unsigned words to vector (immediate index).

LDNF1B: Contiguous load non-fault unsigned bytes to vector (immediate index).

LDNF1D: Contiguous load non-fault doublewords to vector (immediate index).

LDNF1H: Contiguous load non-fault unsigned halfwords to vector (immediate index).

LDNF1SB: Contiguous load non-fault signed bytes to vector (immediate index).

LDNF1SH: Contiguous load non-fault signed halfwords to vector (immediate index).

LDNF1SW: Contiguous load non-fault signed words to vector (immediate index).

LDNF1W: Contiguous load non-fault unsigned words to vector (immediate index).

LDNT1B (scalar plus immediate): Contiguous load non-temporal bytes to vector (immediate index).

LDNT1B (scalar plus scalar): Contiguous load non-temporal bytes to vector (scalar index).

LDNT1B (vector plus scalar): Gather load non-temporal unsigned bytes.

LDNT1D (scalar plus immediate): Contiguous load non-temporal doublewords to vector (immediate index).

LDNT1D (scalar plus scalar): Contiguous load non-temporal doublewords to vector (scalar index).

LDNT1D (vector plus scalar): Gather load non-temporal unsigned doublewords.

LDNT1H (scalar plus immediate): Contiguous load non-temporal halfwords to vector (immediate index).

LDNT1H (scalar plus scalar): Contiguous load non-temporal halfwords to vector (scalar index).

LDNT1H (vector plus scalar): Gather load non-temporal unsigned halfwords.

LDNT1SB: Gather load non-temporal signed bytes.

LDNT1SH: Gather load non-temporal signed halfwords.

LDNT1SW: Gather load non-temporal signed words.

LDNT1W (scalar plus immediate): Contiguous load non-temporal words to vector (immediate index).

LDNT1W (scalar plus scalar): Contiguous load non-temporal words to vector (scalar index).

LDNT1W (vector plus scalar): Gather load non-temporal unsigned words.

LDR (predicate): Load predicate register.

LDR (vector): Load vector register.

LSL (immediate, predicated): Logical shift left by immediate (predicated).

LSL (immediate, unpredicated): Logical shift left by immediate (unpredicated).

LSL (vectors): Logical shift left by vector (predicated).

LSL (wide elements, predicated): Logical shift left by 64-bit wide elements (predicated).

LSL (wide elements, unpredicated): Logical shift left by 64-bit wide elements (unpredicated).

LSLR: Reversed logical shift left by vector (predicated).

LSR (immediate, predicated): Logical shift right by immediate (predicated).

LSR (immediate, unpredicated): Logical shift right by immediate (unpredicated).

LSR (vectors): Logical shift right by vector (predicated).

LSR (wide elements, predicated): Logical shift right by 64-bit wide elements (predicated).

LSR (wide elements, unpredicated): Logical shift right by 64-bit wide elements (unpredicated).

LSRR: Reversed logical shift right by vector (predicated).

MAD: Multiply-add vectors (predicated), writing multiplicand [Zdn = Za + Zdn * Zm].

MATCH: Detect any matching elements, setting the condition flags.

MLA (indexed): Multiply-add to accumulator (indexed).

MLA (vectors): Multiply-add vectors (predicated), writing addend [Zda = Zda + Zn * Zm].

MLS (indexed): Multiply-subtract from accumulator (indexed).

MLS (vectors): Multiply-subtract vectors (predicated), writing addend [Zda = Zda - Zn * Zm].

MOV: Move predicates (zeroing): an alias of AND, ANDS (predicates).

MOV: Move predicate (unpredicated): an alias of ORR, ORRS (predicates).

MOV: Move predicates (merging): an alias of SEL (predicates).

MOV (bitmask immediate): Move logical bitmask immediate to vector (unpredicated): an alias of DUPM.

MOV (immediate, predicated, merging): Move signed integer immediate to vector elements (merging~~predicated~~): an alias of CPY (immediate, merging).

MOV (immediate, predicated, zeroing): Move signed integer immediate to vector elements (zeroing): an alias of CPY (immediate, zeroing).

MOV (immediate, unpredicated): Move signed immediate to vector elements (unpredicated): an alias of DUP (immediate).

~~MOV (predicate, predicated, merging): Move predicates (merging): an alias of SEL (predicates).~~

~~MOV (predicate, predicated, zeroing): Move predicates (zeroing): an alias of AND, ANDS (predicates).~~

~~MOV (predicate, unpredicated): Move predicate (unpredicated): an alias of ORR, ORRS (predicates).~~

MOV (scalar, predicated): Move general-purpose register to vector elements (predicated): an alias of CPY (scalar).

MOV (scalar, unpredicated): Move general-purpose register to vector elements (unpredicated): an alias of DUP (scalar).

MOV (SIMD&FP scalar, predicated): Move SIMD&FP scalar register to vector elements (predicated): an alias of CPY (SIMD&FP scalar).

MOV (SIMD&FP scalar, unpredicated): Move indexed element or SIMD&FP scalar to vector (unpredicated): an alias of DUP (indexed).

MOV (vector, predicated): Move vector elements (predicated): an alias of SEL (vectors).

MOV (vector, unpredicated): Move vector register (unpredicated): an alias of ORR (vectors, unpredicated).

MOVPRFX (predicated): Move prefix (predicated).

MOVPRFX (unpredicated): Move prefix (unpredicated).

MOVS~~ (predicated)~~: Move predicates (zeroing), setting the condition flags: an alias of AND, ANDS (predicates).

MOVS~~ (unpredicated)~~: Move predicate (unpredicated), setting the condition flags: an alias of ORR, ORRS (predicates).

MSB: Multiply-subtract vectors (predicated), writing multiplicand [Zdn = Za - Zdn * Zm].

MUL (immediate): Multiply by immediate (unpredicated).

MUL (indexed): Multiply (indexed).

MUL (vectors, predicated): Multiply vectors (predicated).

MUL (vectors, unpredicated): Multiply vectors (unpredicated).

NAND, NANDS: Bitwise NAND predicates.

NBSL: Bitwise inverted select.

NEG: Negate (predicated).

NMATCH: Detect no matching elements, setting the condition flags.

NOR, NORS: Bitwise NOR predicates.

NOT (predicate): Bitwise invert predicate: an alias of EOR, EORS (predicates).

NOT (vector): Bitwise invert vector (predicated).

NOTS: Bitwise invert predicate, setting the condition flags: an alias of EOR, EORS (predicates).

ORN (immediate): Bitwise inclusive OR with inverted immediate (unpredicated): an alias of ORR (immediate).

ORN, ORNS (predicates): Bitwise inclusive OR inverted predicate.

ORR (immediate): Bitwise inclusive OR with immediate (unpredicated).

ORR (vectors, predicated): Bitwise inclusive OR vectors (predicated).

ORR (vectors, unpredicated): Bitwise inclusive OR vectors (unpredicated).

ORR, ORRS (predicates): Bitwise inclusive OR predicate.

ORV: Bitwise inclusive OR reduction to scalar.

PFALSE: Set all predicate elements to false.

PFIRST: Set the first active predicate element to true.

PMUL: Polynomial multiply vectors (unpredicated).

PMULLB: Polynomial multiply long (bottom).

PMULLT: Polynomial multiply long (top).

PNEXT: Find next active predicate.

PRFB (scalar plus immediate): Contiguous prefetch bytes (immediate index).

PRFB (scalar plus scalar): Contiguous prefetch bytes (scalar index).

PRFB (scalar plus vector): Gather prefetch bytes (scalar plus vector).

PRFB (vector plus immediate): Gather prefetch bytes (vector plus immediate).

PRFD (scalar plus immediate): Contiguous prefetch doublewords (immediate index).

PRFD (scalar plus scalar): Contiguous prefetch doublewords (scalar index).

PRFD (scalar plus vector): Gather prefetch doublewords (scalar plus vector).

PRFD (vector plus immediate): Gather prefetch doublewords (vector plus immediate).

PRFH (scalar plus immediate): Contiguous prefetch halfwords (immediate index).

PRFH (scalar plus scalar): Contiguous prefetch halfwords (scalar index).

PRFH (scalar plus vector): Gather prefetch halfwords (scalar plus vector).

PRFH (vector plus immediate): Gather prefetch halfwords (vector plus immediate).

PRFW (scalar plus immediate): Contiguous prefetch words (immediate index).

PRFW (scalar plus scalar): Contiguous prefetch words (scalar index).

PRFW (scalar plus vector): Gather prefetch words (scalar plus vector).

PRFW (vector plus immediate): Gather prefetch words (vector plus immediate).

PTEST: Set condition flags for predicate.

PTRUE, PTRUES: Initialise predicate from named constraint.

PUNPKHI, PUNPKLO: Unpack and widen half of predicate.

RADDHNB: Rounding add narrow high part (bottom).

RADDHNT: Rounding add narrow high part (top).

RAX1: Bitwise rotate left by 1 and exclusive OR.

RBIT: Reverse bits (predicated).

RDFFR (unpredicated): Read the first-fault register.

RDFFR, RDFFRS (predicated): Return predicate of succesfully loaded elements.

RDVL: Read multiple of vector register size to scalar register.

REV (predicate): Reverse all elements in a predicate.

REV (vector): Reverse all elements in a vector (unpredicated).

REVB, REVH, REVW: Reverse bytes / halfwords / words within elements (predicated).

RSHRNB: Rounding shift right narrow by immediate (bottom).

RSHRNT: Rounding shift right narrow by immediate (top).

RSUBHNB: Rounding subtract narrow high part (bottom).

RSUBHNT: Rounding subtract narrow high part (top).

SABA: Signed absolute difference and accumulate.

SABALB: Signed absolute difference and accumulate long (bottom).

SABALT: Signed absolute difference and accumulate long (top).

SABD: Signed absolute difference (predicated).

SABDLB: Signed absolute difference long (bottom).

SABDLT: Signed absolute difference long (top).

SADALP: Signed add and accumulate long pairwise.

SADDLB: Signed add long (bottom).

SADDLBT: Signed add long (bottom + top).

SADDLT: Signed add long (top).

SADDV: Signed add reduction to scalar.

SADDWB: Signed add wide (bottom).

SADDWT: Signed add wide (top).

SBCLB: Subtract with carry long (bottom).

SBCLT: Subtract with carry long (top).

SCVTF: Signed integer convert to floating-point (predicated).

SDIV: Signed divide (predicated).

SDIVR: Signed reversed divide (predicated).

SDOT (indexed): Signed dot product by indexed quadtuplet.

SDOT (vectors): Signed dot product.

SEL (predicates): Conditionally select elements from two predicates.

SEL (vectors): Conditionally select elements from two vectors.

SETFFR: Initialise the first-fault register to all true.

SHADD: Signed halving addition.

SHRNB: Shift right narrow by immediate (bottom).

SHRNT: Shift right narrow by immediate (top).

SHSUB: Signed halving subtract.

SHSUBR: Signed halving subtract reversed vectors.

SLI: Shift left and insert (immediate).

SM4E: SM4 encryption and decryption.

SM4EKEY: SM4 key updates.

SMAX (immediate): Signed maximum with immediate (unpredicated).

SMAX (vectors): Signed maximum vectors (predicated).

SMAXP: Signed maximum pairwise.

SMAXV: Signed maximum reduction to scalar.

SMIN (immediate): Signed minimum with immediate (unpredicated).

SMIN (vectors): Signed minimum vectors (predicated).

SMINP: Signed minimum pairwise.

SMINV: Signed minimum reduction to scalar.

SMLALB (indexed): Signed multiply-add long to accumulator (bottom, indexed).

SMLALB (vectors): Signed multiply-add long to accumulator (bottom).

SMLALT (indexed): Signed multiply-add long to accumulator (top, indexed).

SMLALT (vectors): Signed multiply-add long to accumulator (top).

SMLSLB (indexed): Signed multiply-subtract long from accumulator (bottom, indexed).

SMLSLB (vectors): Signed multiply-subtract long from accumulator (bottom).

SMLSLT (indexed): Signed multiply-subtract long from accumulator (top, indexed).

SMLSLT (vectors): Signed multiply-subtract long from accumulator (top).

SMULH (predicated): Signed multiply returning high half (predicated).

SMULH (unpredicated): Signed multiply returning high half (unpredicated).

SMULLB (indexed): Signed multiply long (bottom, indexed).

SMULLB (vectors): Signed multiply long (bottom).

SMULLT (indexed): Signed multiply long (top, indexed).

SMULLT (vectors): Signed multiply long (top).

SPLICE: Splice two vectors under predicate control.

SQABS: Signed saturating absolute value.

SQADD (immediate): Signed saturating add immediate (unpredicated).

SQADD (vectors, predicated): Signed saturating addition (predicated).

SQADD (vectors, unpredicated): Signed saturating add vectors (unpredicated).

SQCADD: Saturating complex integer add with rotate.

SQDECB: Signed saturating decrement scalar by multiple of 8-bit predicate constraint element count.

SQDECD (scalar): Signed saturating decrement scalar by multiple of 64-bit predicate constraint element count.

SQDECD (vector): Signed saturating decrement vector by multiple of 64-bit predicate constraint element count.

SQDECH (scalar): Signed saturating decrement scalar by multiple of 16-bit predicate constraint element count.

SQDECH (vector): Signed saturating decrement vector by multiple of 16-bit predicate constraint element count.

SQDECP (scalar): Signed saturating decrement scalar by countactive ofpredicate truelement predicate elements.count.

SQDECP (vector): Signed saturating decrement vector by countactive ofpredicate truelement predicate elements.count.

SQDECW (scalar): Signed saturating decrement scalar by multiple of 32-bit predicate constraint element count.

SQDECW (vector): Signed saturating decrement vector by multiple of 32-bit predicate constraint element count.

SQDMLALB (indexed): Signed saturating doubling multiply-add long to accumulator (bottom, indexed).

SQDMLALB (vectors): Signed saturating doubling multiply-add long to accumulator (bottom).

SQDMLALBT: Signed saturating doubling multiply-add long to accumulator (bottom × top).

SQDMLALT (indexed): Signed saturating doubling multiply-add long to accumulator (top, indexed).

SQDMLALT (vectors): Signed saturating doubling multiply-add long to accumulator (top).

SQDMLSLB (indexed): Signed saturating doubling multiply-subtract long from accumulator (bottom, indexed).

SQDMLSLB (vectors): Signed saturating doubling multiply-subtract long from accumulator (bottom).

SQDMLSLBT: Signed saturating doubling multiply-subtract long from accumulator (bottom × top).

SQDMLSLT (indexed): Signed saturating doubling multiply-subtract long from accumulator (top, indexed).

SQDMLSLT (vectors): Signed saturating doubling multiply-subtract long from accumulator (top).

SQDMULH (indexed): Signed saturating doubling multiply high (indexed).

SQDMULH (vectors): Signed saturating doubling multiply high (unpredicated).

SQDMULLB (indexed): Signed saturating doubling multiply long (bottom, indexed).

SQDMULLB (vectors): Signed saturating doubling multiply long (bottom).

SQDMULLT (indexed): Signed saturating doubling multiply long (top, indexed).

SQDMULLT (vectors): Signed saturating doubling multiply long (top).

SQINCB: Signed saturating increment scalar by multiple of 8-bit predicate constraint element count.

SQINCD (scalar): Signed saturating increment scalar by multiple of 64-bit predicate constraint element count.

SQINCD (vector): Signed saturating increment vector by multiple of 64-bit predicate constraint element count.

SQINCH (scalar): Signed saturating increment scalar by multiple of 16-bit predicate constraint element count.

SQINCH (vector): Signed saturating increment vector by multiple of 16-bit predicate constraint element count.

SQINCP (scalar): Signed saturating increment scalar by countactive ofpredicate truelement predicate elements.count.

SQINCP (vector): Signed saturating increment vector by countactive ofpredicate truelement predicate elements.count.

SQINCW (scalar): Signed saturating increment scalar by multiple of 32-bit predicate constraint element count.

SQINCW (vector): Signed saturating increment vector by multiple of 32-bit predicate constraint element count.

SQNEG: Signed saturating negate.

SQRDCMLAH (indexed): Saturating rounding doubling complex integer multiply-add high with rotate (indexed).

SQRDCMLAH (vectors): Saturating rounding doubling complex integer multiply-add high with rotate.

SQRDMLAH (indexed): Signed saturating rounding doubling multiply-add high to accumulator (indexed).

SQRDMLAH (vectors): Signed saturating rounding doubling multiply-add high to accumulator (unpredicated).

SQRDMLSH (indexed): Signed saturating rounding doubling multiply-subtract high from accumulator (indexed).

SQRDMLSH (vectors): Signed saturating rounding doubling multiply-subtract high from accumulator (unpredicated).

SQRDMULH (indexed): Signed saturating rounding doubling multiply high (indexed).

SQRDMULH (vectors): Signed saturating rounding doubling multiply high (unpredicated).

SQRSHL: Signed saturating rounding shift left by vector (predicated).

SQRSHLR: Signed saturating rounding shift left reversed vectors (predicated).

SQRSHRNB: Signed saturating rounding shift right narrow by immediate (bottom).

SQRSHRNT: Signed saturating rounding shift right narrow by immediate (top).

SQRSHRUNB: Signed saturating rounding shift right unsigned narrow by immediate (bottom).

SQRSHRUNT: Signed saturating rounding shift right unsigned narrow by immediate (top).

SQSHL (immediate): Signed saturating shift left by immediate.

SQSHL (vectors): Signed saturating shift left by vector (predicated).

SQSHLR: Signed saturating shift left reversed vectors (predicated).

SQSHLU: Signed saturating shift left unsigned by immediate.

SQSHRNB: Signed saturating shift right narrow by immediate (bottom).

SQSHRNT: Signed saturating shift right narrow by immediate (top).

SQSHRUNB: Signed saturating shift right unsigned narrow by immediate (bottom).

SQSHRUNT: Signed saturating shift right unsigned narrow by immediate (top).

SQSUB (immediate): Signed saturating subtract immediate (unpredicated).

SQSUB (vectors, predicated): Signed saturating subtraction (predicated).

SQSUB (vectors, unpredicated): Signed saturating subtract vectors (unpredicated).

SQSUBR: Signed saturating subtraction reversed vectors (predicated).

SQXTNB: Signed saturating extract narrow (bottom).

SQXTNT: Signed saturating extract narrow (top).

SQXTUNB: Signed saturating unsigned extract narrow (bottom).

SQXTUNT: Signed saturating unsigned extract narrow (top).

SRHADD: Signed rounding halving addition.

SRI: Shift right and insert (immediate).

SRSHL: Signed rounding shift left by vector (predicated).

SRSHLR: Signed rounding shift left reversed vectors (predicated).

SRSHR: Signed rounding shift right by immediate.

SRSRA: Signed rounding shift right and accumulate (immediate).

SSHLLB: Signed shift left long by immediate (bottom).

SSHLLT: Signed shift left long by immediate (top).

SSRA: Signed shift right and accumulate (immediate).

SSUBLB: Signed subtract long (bottom).

SSUBLBT: Signed subtract long (bottom - top).

SSUBLT: Signed subtract long (top).

SSUBLTB: Signed subtract long (top - bottom).

SSUBWB: Signed subtract wide (bottom).

SSUBWT: Signed subtract wide (top).

ST1B (scalar plus immediate): Contiguous store bytes from vector (immediate index).

ST1B (scalar plus scalar): Contiguous store bytes from vector (scalar index).

ST1B (scalar plus vector): Scatter store bytes from a vector (vector index).

ST1B (vector plus immediate): Scatter store bytes from a vector (immediate index).

ST1D (scalar plus immediate): Contiguous store doublewords from vector (immediate index).

ST1D (scalar plus scalar): Contiguous store doublewords from vector (scalar index).

ST1D (scalar plus vector): Scatter store doublewords from a vector (vector index).

ST1D (vector plus immediate): Scatter store doublewords from a vector (immediate index).

ST1H (scalar plus immediate): Contiguous store halfwords from vector (immediate index).

ST1H (scalar plus scalar): Contiguous store halfwords from vector (scalar index).

ST1H (scalar plus vector): Scatter store halfwords from a vector (vector index).

ST1H (vector plus immediate): Scatter store halfwords from a vector (immediate index).

ST1W (scalar plus immediate): Contiguous store words from vector (immediate index).

ST1W (scalar plus scalar): Contiguous store words from vector (scalar index).

ST1W (scalar plus vector): Scatter store words from a vector (vector index).

ST1W (vector plus immediate): Scatter store words from a vector (immediate index).

ST2B (scalar plus immediate): Contiguous store two-byte structures from two vectors (immediate index).

ST2B (scalar plus scalar): Contiguous store two-byte structures from two vectors (scalar index).

ST2D (scalar plus immediate): Contiguous store two-doubleword structures from two vectors (immediate index).

ST2D (scalar plus scalar): Contiguous store two-doubleword structures from two vectors (scalar index).

ST2H (scalar plus immediate): Contiguous store two-halfword structures from two vectors (immediate index).

ST2H (scalar plus scalar): Contiguous store two-halfword structures from two vectors (scalar index).

ST2W (scalar plus immediate): Contiguous store two-word structures from two vectors (immediate index).

ST2W (scalar plus scalar): Contiguous store two-word structures from two vectors (scalar index).

ST3B (scalar plus immediate): Contiguous store three-byte structures from three vectors (immediate index).

ST3B (scalar plus scalar): Contiguous store three-byte structures from three vectors (scalar index).

ST3D (scalar plus immediate): Contiguous store three-doubleword structures from three vectors (immediate index).

ST3D (scalar plus scalar): Contiguous store three-doubleword structures from three vectors (scalar index).

ST3H (scalar plus immediate): Contiguous store three-halfword structures from three vectors (immediate index).

ST3H (scalar plus scalar): Contiguous store three-halfword structures from three vectors (scalar index).

ST3W (scalar plus immediate): Contiguous store three-word structures from three vectors (immediate index).

ST3W (scalar plus scalar): Contiguous store three-word structures from three vectors (scalar index).

ST4B (scalar plus immediate): Contiguous store four-byte structures from four vectors (immediate index).

ST4B (scalar plus scalar): Contiguous store four-byte structures from four vectors (scalar index).

ST4D (scalar plus immediate): Contiguous store four-doubleword structures from four vectors (immediate index).

ST4D (scalar plus scalar): Contiguous store four-doubleword structures from four vectors (scalar index).

ST4H (scalar plus immediate): Contiguous store four-halfword structures from four vectors (immediate index).

ST4H (scalar plus scalar): Contiguous store four-halfword structures from four vectors (scalar index).

ST4W (scalar plus immediate): Contiguous store four-word structures from four vectors (immediate index).

ST4W (scalar plus scalar): Contiguous store four-word structures from four vectors (scalar index).

STNT1B (scalar plus immediate): Contiguous store non-temporal bytes from vector (immediate index).

STNT1B (scalar plus scalar): Contiguous store non-temporal bytes from vector (scalar index).

STNT1B (vector plus scalar): Scatter store non-temporal bytes.

STNT1D (scalar plus immediate): Contiguous store non-temporal doublewords from vector (immediate index).

STNT1D (scalar plus scalar): Contiguous store non-temporal doublewords from vector (scalar index).

STNT1D (vector plus scalar): Scatter store non-temporal doublewords.

STNT1H (scalar plus immediate): Contiguous store non-temporal halfwords from vector (immediate index).

STNT1H (scalar plus scalar): Contiguous store non-temporal halfwords from vector (scalar index).

STNT1H (vector plus scalar): Scatter store non-temporal halfwords.

STNT1W (scalar plus immediate): Contiguous store non-temporal words from vector (immediate index).

STNT1W (scalar plus scalar): Contiguous store non-temporal words from vector (scalar index).

STNT1W (vector plus scalar): Scatter store non-temporal words.

STR (predicate): Store predicate register.

STR (vector): Store vector register.

SUB (immediate): Subtract immediate (unpredicated).

SUB (vectors, predicated): Subtract vectors (predicated).

SUB (vectors, unpredicated): Subtract vectors (unpredicated).

SUBHNB: Subtract narrow high part (bottom).

SUBHNT: Subtract narrow high part (top).

SUBR (immediate): Reversed subtract from immediate (unpredicated).

SUBR (vectors): Reversed subtract vectors (predicated).

SUNPKHI, SUNPKLO: Signed unpack and extend half of vector.

SUQADD: Signed saturating addition of unsigned value.

SXTB, SXTH, SXTW: Signed byte / halfword / word extend (predicated).

TBX: Programmable table lookup in single vector table (merging).

TRN1, TRN2 (predicates): Interleave even or odd elements from two predicates.

TRN1, TRN2 (vectors): Interleave even or odd elements from two vectors.

UABA: Unsigned absolute difference and accumulate.

UABALB: Unsigned absolute difference and accumulate long (bottom).

UABALT: Unsigned absolute difference and accumulate long (top).

UABD: Unsigned absolute difference (predicated).

UABDLB: Unsigned absolute difference long (bottom).

UABDLT: Unsigned absolute difference long (top).

UADALP: Unsigned add and accumulate long pairwise.

UADDLB: Unsigned add long (bottom).

UADDLT: Unsigned add long (top).

UADDV: Unsigned add reduction to scalar.

UADDWB: Unsigned add wide (bottom).

UADDWT: Unsigned add wide (top).

UCVTF: Unsigned integer convert to floating-point (predicated).

UDIV: Unsigned divide (predicated).

UDIVR: Unsigned reversed divide (predicated).

UDOT (indexed): Unsigned dot product by indexed quadtuplet.

UDOT (vectors): Unsigned dot product.

UHADD: Unsigned halving addition.

UHSUB: Unsigned halving subtract.

UHSUBR: Unsigned halving subtract reversed vectors.

UMAX (immediate): Unsigned maximum with immediate (unpredicated).

UMAX (vectors): Unsigned maximum vectors (predicated).

UMAXP: Unsigned maximum pairwise.

UMAXV: Unsigned maximum reduction to scalar.

UMIN (immediate): Unsigned minimum with immediate (unpredicated).

UMIN (vectors): Unsigned minimum vectors (predicated).

UMINP: Unsigned minimum pairwise.

UMINV: Unsigned minimum reduction to scalar.

UMLALB (indexed): Unsigned multiply-add long to accumulator (bottom, indexed).

UMLALB (vectors): Unsigned multiply-add long to accumulator (bottom).

UMLALT (indexed): Unsigned multiply-add long to accumulator (top, indexed).

UMLALT (vectors): Unsigned multiply-add long to accumulator (top).

UMLSLB (indexed): Unsigned multiply-subtract long from accumulator (bottom, indexed).

UMLSLB (vectors): Unsigned multiply-subtract long from accumulator (bottom).

UMLSLT (indexed): Unsigned multiply-subtract long from accumulator (top, indexed).

UMLSLT (vectors): Unsigned multiply-subtract long from accumulator (top).

UMULH (predicated): Unsigned multiply returning high half (predicated).

UMULH (unpredicated): Unsigned multiply returning high half (unpredicated).

UMULLB (indexed): Unsigned multiply long (bottom, indexed).

UMULLB (vectors): Unsigned multiply long (bottom).

UMULLT (indexed): Unsigned multiply long (top, indexed).

UMULLT (vectors): Unsigned multiply long (top).

UQADD (immediate): Unsigned saturating add immediate (unpredicated).

UQADD (vectors, predicated): Unsigned saturating addition (predicated).

UQADD (vectors, unpredicated): Unsigned saturating add vectors (unpredicated).

UQDECB: Unsigned saturating decrement scalar by multiple of 8-bit predicate constraint element count.

UQDECD (scalar): Unsigned saturating decrement scalar by multiple of 64-bit predicate constraint element count.

UQDECD (vector): Unsigned saturating decrement vector by multiple of 64-bit predicate constraint element count.

UQDECH (scalar): Unsigned saturating decrement scalar by multiple of 16-bit predicate constraint element count.

UQDECH (vector): Unsigned saturating decrement vector by multiple of 16-bit predicate constraint element count.

UQDECP (scalar): Unsigned saturating decrement scalar by countactive ofpredicate truelement predicate elements.count.

UQDECP (vector): Unsigned saturating decrement vector by countactive ofpredicate truelement predicate elements.count.

UQDECW (scalar): Unsigned saturating decrement scalar by multiple of 32-bit predicate constraint element count.

UQDECW (vector): Unsigned saturating decrement vector by multiple of 32-bit predicate constraint element count.

UQINCB: Unsigned saturating increment scalar by multiple of 8-bit predicate constraint element count.

UQINCD (scalar): Unsigned saturating increment scalar by multiple of 64-bit predicate constraint element count.

UQINCD (vector): Unsigned saturating increment vector by multiple of 64-bit predicate constraint element count.

UQINCH (scalar): Unsigned saturating increment scalar by multiple of 16-bit predicate constraint element count.

UQINCH (vector): Unsigned saturating increment vector by multiple of 16-bit predicate constraint element count.

UQINCP (scalar): Unsigned saturating increment scalar by countactive ofpredicate truelement predicate elements.count.

UQINCP (vector): Unsigned saturating increment vector by countactive ofpredicate truelement predicate elements.count.

UQINCW (scalar): Unsigned saturating increment scalar by multiple of 32-bit predicate constraint element count.

UQINCW (vector): Unsigned saturating increment vector by multiple of 32-bit predicate constraint element count.

UQRSHL: Unsigned saturating rounding shift left by vector (predicated).

UQRSHLR: Unsigned saturating rounding shift left reversed vectors (predicated).

UQRSHRNB: Unsigned saturating rounding shift right narrow by immediate (bottom).

UQRSHRNT: Unsigned saturating rounding shift right narrow by immediate (top).

UQSHL (immediate): Unsigned saturating shift left by immediate.

UQSHL (vectors): Unsigned saturating shift left by vector (predicated).

UQSHLR: Unsigned saturating shift left reversed vectors (predicated).

UQSHRNB: Unsigned saturating shift right narrow by immediate (bottom).

UQSHRNT: Unsigned saturating shift right narrow by immediate (top).

UQSUB (immediate): Unsigned saturating subtract immediate (unpredicated).

UQSUB (vectors, predicated): Unsigned saturating subtraction (predicated).

UQSUB (vectors, unpredicated): Unsigned saturating subtract vectors (unpredicated).

UQSUBR: Unsigned saturating subtraction reversed vectors (predicated).

UQXTNB: Unsigned saturating extract narrow (bottom).

UQXTNT: Unsigned saturating extract narrow (top).

URECPE: Unsigned reciprocal estimate (predicated).

URHADD: Unsigned rounding halving addition.

URSHL: Unsigned rounding shift left by vector (predicated).

URSHLR: Unsigned rounding shift left reversed vectors (predicated).

URSHR: Unsigned rounding shift right by immediate.

URSQRTE: Unsigned reciprocal square root estimate (predicated).

URSRA: Unsigned rounding shift right and accumulate (immediate).

USHLLB: Unsigned shift left long by immediate (bottom).

USHLLT: Unsigned shift left long by immediate (top).

USQADD: Unsigned saturating addition of signed value.

USRA: Unsigned shift right and accumulate (immediate).

USUBLB: Unsigned subtract long (bottom).

USUBLT: Unsigned subtract long (top).

USUBWB: Unsigned subtract wide (bottom).

USUBWT: Unsigned subtract wide (top).

UUNPKHI, UUNPKLO: Unsigned unpack and extend half of vector.

UXTB, UXTH, UXTW: Unsigned byte / halfword / word extend (predicated).

UZP1, UZP2 (predicates): Concatenate even or odd elements from two predicates.

UZP1, UZP2 (vectors): Concatenate even or odd elements from two vectors.

WHILEGE: While decrementing signed scalar greater than or equal to scalar.

WHILEGT: While decrementing signed scalar greater than scalar.

WHILEHI: While decrementing unsigned scalar higher than scalar.

WHILEHS: While decrementing unsigned scalar higher or same as scalar.

WHILELE: While incrementing signed scalar less than or equal to scalar.

WHILELO: While incrementing unsigned scalar lower than scalar.

WHILELS: While incrementing unsigned scalar lower or same as scalar.

WHILELT: While incrementing signed scalar less than scalar.

WHILERW: While free of read-after-write conflicts.

WHILEWR: While free of write-after-read/write conflicts.

WRFFR: Write the first-fault register.

XAR: Bitwise exclusive OR and rotate right by immediate.

ZIP1, ZIP2 (predicates): Interleave elements from two half predicates.

ZIP1, ZIP2 (vectors): Interleave elements from two half vectors.

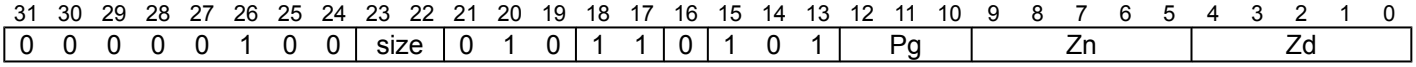
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ABS

Absolute value (predicated).

Compute the absolute value of the signed integer in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
ABS <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    integer element = SInt(Elem[operand, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        element = Abs(element);
        Elem[result, e, esize] = element<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

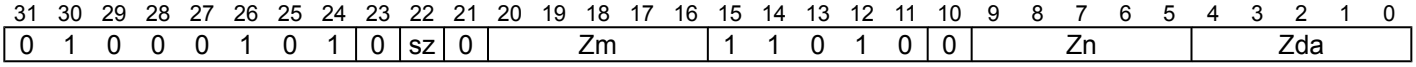
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ADCLB

Add with carry long (bottom).

Add the even-numbered elements of the first source vector and the 1-bit carry from the least-significant bit of the odd-numbered elements of the second source vector to the even-numbered elements of the destination and accumulator vector. The 1-bit carry output is placed in the corresponding odd-numbered element of the destination vector.



SVE2

```
ADCLB <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “sz”:

sz	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(VL) operand = Z[n];
bits(VL) carries = Z[m];
bits(VL) result = Z[da];

for p = 0 to pairs-1
    bits(esize) element1 = Elem[result, 2*p + 0, esize];
    bits(esize) element2 = Elem[operand, 2*p + 0, esize];
    bit carry_in = Elem[carries, 2*p + 1, esize]<0>;

    (res, nzcv) = AddWithCarry(element1, element2, carry_in);
    carry_out = nzcv<1>;

    Elem[result, 2*p + 0, esize] = res;
    Elem[result, 2*p + 1, esize] = ZeroExtend(carry_out);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

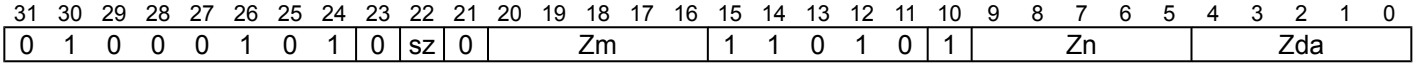
(old) htmldiff from- (new)

(old) htmldiff from- (new)

ADCLT

Add with carry long (top).

Add the odd-numbered elements of the first source vector and the 1-bit carry from the least-significant bit of the odd-numbered elements of the second source vector to the even-numbered elements of the destination and accumulator vector. The 1-bit carry output is placed in the corresponding odd-numbered element of the destination vector.



SVE2

```
ADCLT <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “sz”:

sz	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(VL) operand = Z[n];
bits(VL) carries = Z[m];
bits(VL) result = Z[da];

for p = 0 to pairs-1
    bits(esize) element1 = Elem[result, 2*p + 0, esize];
    bits(esize) element2 = Elem[operand, 2*p + 1, esize];
    bit carry_in = Elem[carries, 2*p + 1, esize]<0>;

    (res, nzcv) = AddWithCarry(element1, element2, carry_in);
    carry_out = nzcv<1>;

    Elem[result, 2*p + 0, esize] = res;
    Elem[result, 2*p + 1, esize] = ZeroExtend(carry_out);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

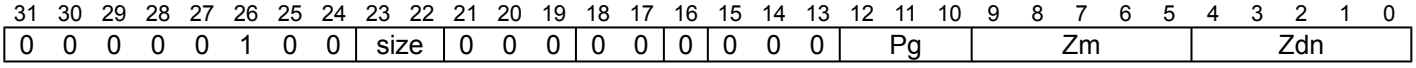
(old) htmldiff from- (new)

(old) htmldiff from- (new)

ADD (vectors, predicated)

Add vectors (predicated).

Add active elements of the second source vector to corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
ADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1 + element2;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

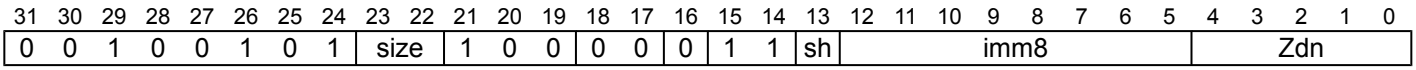
ADD (immediate)

Add immediate (unpredicated).

Add an unsigned immediate to each element of the source vector, and destructively place the results in the corresponding elements of the source vector. This instruction is unpredicated.

The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.

The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
ADD <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    Elem[result, e, esize] = element1 + imm;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

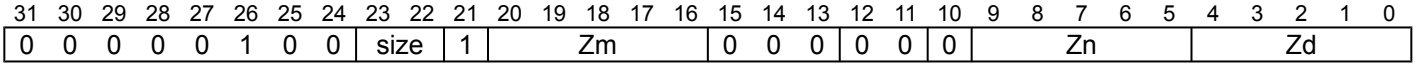
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ADD (vectors, unpredicated)

Add vectors (unpredicated).

Add all elements of the second source vector to corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE

```
ADD <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    Elem[result, e, esize] = element1 + element2;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

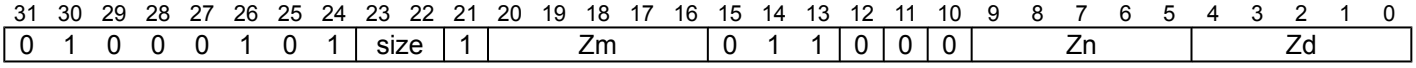
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ADDHNB

Add narrow high part (bottom).

Add each vector element of the first source vector to the corresponding vector element of the second source vector, and place the most significant half of the result in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. This instruction is unpredicated.



SVE2

```
ADDHNB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = (element1 + element2) >> halfesize;
    Elem[result, 2*e + 0, halfesize] = res<halfesize-1:0>;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

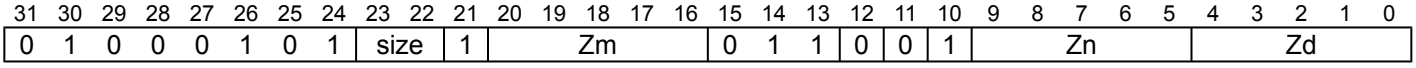
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ADDHNT

Add narrow high part (top).

Add each vector element of the first source vector to the corresponding vector element of the second source vector, and place the most significant half of the result in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. This instruction is unpredicated.



SVE2

```
ADDHNT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = (element1 + element2) >> halfesize;
    Elem[result, 2*e + 1, halfesize] = res<halfesize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

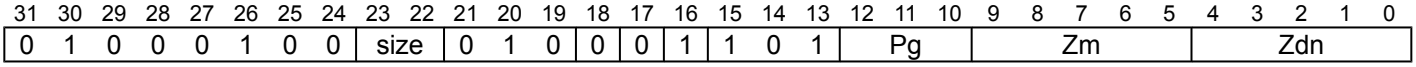
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ADDP

Add pairwise.

Add pairs of adjacent elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
ADDP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer element1;
integer element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand1, e, esize];
    else
        if IsEven(e) then
            element1 = UInt(Elem[operand1, e + 0, esize]);
            element2 = UInt(Elem[operand1, e + 1, esize]);
        else
            element1 = UInt(Elem[operand2, e - 1, esize]);
            element2 = UInt(Elem[operand2, e + 0, esize]);
        integer res = element1 + element2;
        Elem[result, e, esize] = res<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

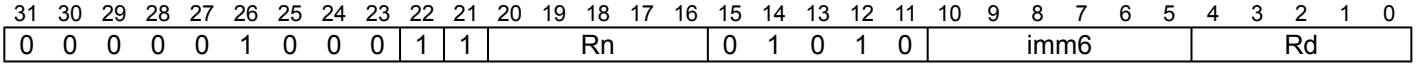
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ADDPL

Add multiple of predicate register size to scalar register.

Add the current predicate register size in bytes multiplied by an immediate in the range -32 to 31 to the 64-bit source general-purpose register or current stack pointer and place the result in the 64-bit destination general-purpose register or current stack pointer.



SVE

```
ADDPL <Xd|SP>, <Xn|SP>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer n = UInt(Rn);
integer d = UInt(Rd);
integer imm = SInt(imm6);
```

Assembler Symbols

<Xd|SP>	Is the 64-bit name of the destination general-purpose register or stack pointer, encoded in the "Rd" field.
<Xn|SP>	Is the 64-bit name of the source general-purpose register or stack pointer, encoded in the "Rn" field.
<imm>	Is the signed immediate operand, in the range -32 to 31, encoded in the "imm6" field.

Operation

```
CheckSVEEnabled();
bits(64) operand1 = if n == 31 then SP[] else X[n];
bits(64) result = operand1 + (imm * (PL DIV 8));

if d == 31 then
    SP[] = result;
else
    X[d] = result;
```

Operational information

If PSTATE.DIT is 1:

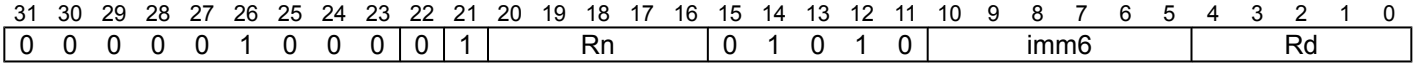
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ADDVL

Add multiple of vector register size to scalar register.

Add the current vector register size in bytes multiplied by an immediate in the range -32 to 31 to the 64-bit source general-purpose register or current stack pointer, and place the result in the 64-bit destination general-purpose register or current stack pointer.



SVE

```
ADDVL <Xd|SP>, <Xn|SP>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer n = UInt(Rn);
integer d = UInt(Rd);
integer imm = SInt(imm6);
```

Assembler Symbols

<Xd|SP>	Is the 64-bit name of the destination general-purpose register or stack pointer, encoded in the "Rd" field.
<Xn|SP>	Is the 64-bit name of the source general-purpose register or stack pointer, encoded in the "Rn" field.
<imm>	Is the signed immediate operand, in the range -32 to 31, encoded in the "imm6" field.

Operation

```
CheckSVEEnabled();
bits(64) operand1 = if n == 31 then SP[] else X[n];
bits(64) result = operand1 + (imm * (VL DIV 8));

if d == 31 then
    SP[] = result;
else
    X[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

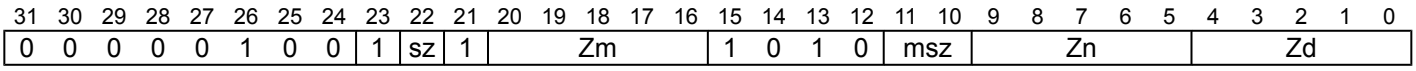
ADR

Compute vector address.

Optionally sign or zero-extend the least significant 32-bits of each element from a vector of offsets or indices in the second source vector, scale each index by 2, 4 or 8, add to a vector of base addresses from the first source vector, and place the resulting addresses in the destination vector. This instruction is unpredicated.

It has encodings from 3 classes: Packed offsets , Unpacked 32-bit signed offsets and Unpacked 32-bit unsigned offsets

Packed offsets

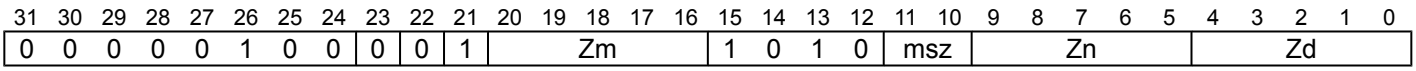


Packed offsets

```
ADR <Zd>.<T>, [<Zn>.<T>, <Zm>.<T>{, <mod> <amount>}]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer osize = esize;
boolean unsigned = TRUE;
integer mbytes = 1 << UInt(msz);
```

Unpacked 32-bit signed offsets

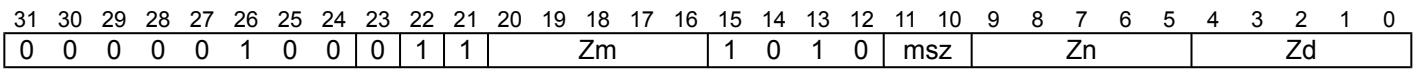


Unpacked 32-bit signed offsets

```
ADR <Zd>.D, [<Zn>.D, <Zm>.D, SXTW{ <amount>}]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer osize = 32;
boolean unsigned = FALSE;
integer mbytes = 1 << UInt(msz);
```

Unpacked 32-bit unsigned offsets



Unpacked 32-bit unsigned offsets

```
ADR <Zd>.D, [<Zn>.D, <Zm>.D, UXTW{ <amount>}]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer osize = 32;
boolean unsigned = TRUE;
integer mbytes = 1 << UInt(msz);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “sz”:

sz	<T>
0	S
1	D

<Zn> Is the name of the base scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the offset scalable vector register, encoded in the "Zm" field.

<mod> Is the index extend and shift specifier, encoded in “msz”:

msz	<mod>
00	[absent]
x1	LSL
10	LSL

<amount> Is the index shift amount, encoded in “msz”:

msz	<amount>
00	[absent]
01	#1
10	#2
11	#3

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) base = Z[n];
bits(VL) offs = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) addr = Elem[base, e, esize];
    integer offset = Int(Elem[offs, e, esize]<osize-1:0>, unsigned);
    Elem[result, e, esize] = addr + (offset * mbytes);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

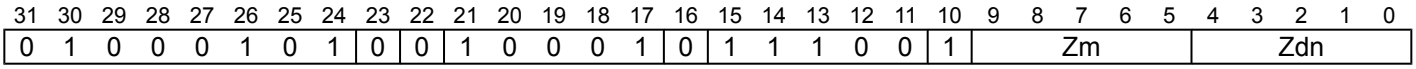
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T222~~019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

AESD

AES single round decryption.

The AESD instruction reads a 16-byte state array from each 128-bit segment of the first source vector, together with a round key from the corresponding 128-bit segment of the second source vector. Each state array undergoes a single round of the ADDROUNDKEY(), INVSUBBYTES() and INVSHIFTROWS() transformations in accordance with the AES standard. Each updated state array is destructively placed in the corresponding segment of the first source vector. This instruction is unpredicated.



SVE2

```
AESD <Zdn>.B, <Zdn>.B, <Zm>.B
```

```
if !HaveSVE2AES() then UNDEFINED;
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

result = operand1 EOR operand2;
for s = 0 to segments-1
    Elem[result, s, 128] = AESInvSubBytes(AESInvShiftRows(Elem[result, s, 128]));

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

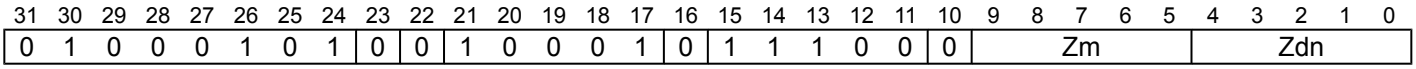
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

AESE

AES single round encryption.

The AESE instruction reads a 16-byte state array from each 128-bit segment of the first source vector together with a round key from the corresponding 128-bit segment of the second source vector. Each state array undergoes a single round of the ADDROUNDKEY(), SUBBYTES() and SHIFTROWS() transformations in accordance with the AES standard. Each updated state array is destructively placed in the corresponding segment of the first source vector. This instruction is unpredicated.



SVE2

```
AESE <Zdn>.B, <Zdn>.B, <Zm>.B
```

```
if !HaveSVE2AES() then UNDEFINED;
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

result = operand1 EOR operand2;
for s = 0 to segments-1
    Elem[result, s, 128] = AESSubBytes(AESShiftRows(Elem[result, s, 128]));

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

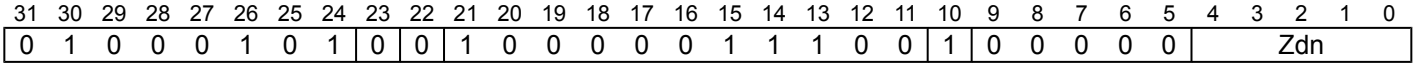
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

AESIMC

AES inverse mix columns.

The AESIMC instruction reads a 16-byte state array from each 128-bit segment of the source register, and performs a single round of the INVMIXCOLUMNS() transformation on each state array in accordance with the AES standard. Each updated state array is destructively placed in the corresponding segment of the first source vector. This instruction is unpredicated.



SVE2

```
AESIMC <Zdn>.B, <Zdn>.B
```

```
if !HaveSVE2AES() then UNDEFINED;
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
bits(VL) operand = Z[dn];
bits(VL) result;

for s = 0 to segments-1
    Elem[result, s, 128] = AESInvMixColumns(Elem[operand, s, 128]);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

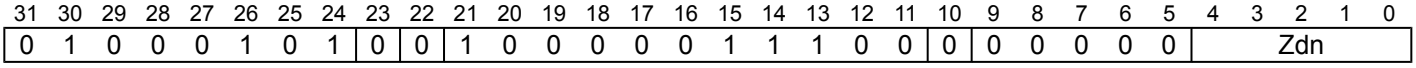
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

AESMC

AES mix columns.

The AESMC instruction reads a 16-byte state array from each 128-bit segment of the source register, and performs a single round of the MIXCOLUMNS() transformation on each state array in accordance with the AES standard. Each updated state array is destructively placed in the corresponding segment of the first source vector. This instruction is unpredicated.



SVE2

```
AESMC <Zdn>.B, <Zdn>.B
```

```
if !HaveSVE2AES() then UNDEFINED;
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
bits(VL) operand = Z[dn];
bits(VL) result;

for s = 0 to segments-1
    Elem[result, s, 128] = AESMixColumns(Elem[operand, s, 128]);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

AND, ANDS (predicates)

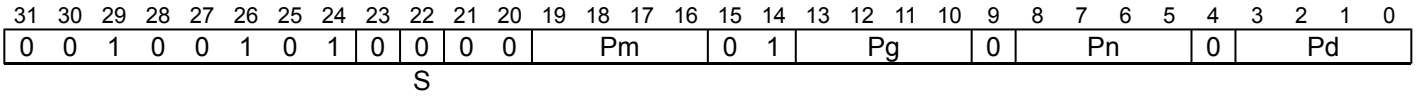
Bitwise AND predicates.

Bitwise AND active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

This instruction is used by the aliases MOVS ~~(predicated)~~, and MOV ~~(predicate, predicated, zeroing)~~.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

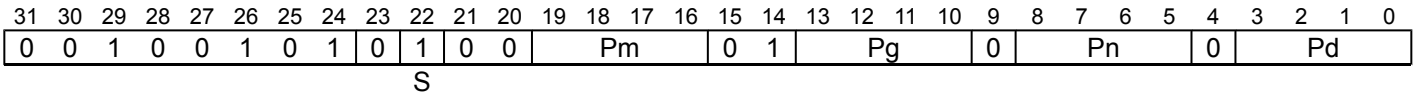


Not setting the condition flags

```
AND <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
ANDS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Alias Conditions

Alias	Is preferred when
MOVS ~~(predicated)~~	`S == '1' && Pn == Pm`
MOV ~~(predicate, predicated, zeroing)~~	`S == '0' && Pn == Pm`

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = element1 AND element2;
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

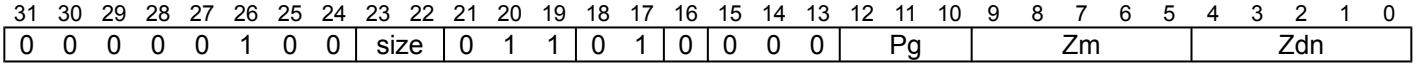
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

AND (vectors, predicated)

Bitwise AND vectors (predicated).

Bitwise AND active elements of the second source vector with corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
AND <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1 AND element2;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

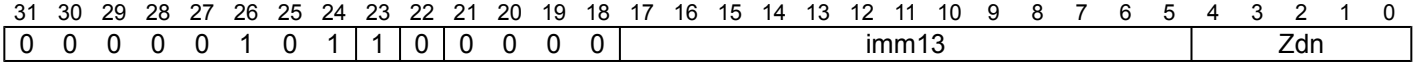
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

AND (immediate)

Bitwise AND with immediate (unpredicated).

Bitwise AND an immediate with each 64-bit element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is a 64-bit value consisting of a single run of ones or zeros repeating every 2, 4, 8, 16, 32 or 64 bits. This instruction is unpredicated.

This instruction is used by the pseudo-instruction BIC (immediate).



SVE

```
AND <Zdn>.<T>, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
integer dn = UInt(Zdn);
bits(64) imm;
(imm, -) = DecodeBitMasks(imm13<12>, imm13<5:0>, imm13<11:6>, TRUE);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “imm13<12>:imm13<5:0>”:

imm13<12>	imm13<5:0>	<T>
0	0xxxxx	S
0	10xxxx	H
0	110xxx	B
0	1110xx	B
0	11110x	B
0	111110	RESERVED
0	111111	RESERVED
1	xxxxxx	D

<const> Is a 64, 32, 16 or 8-bit bitmask consisting of replicated 2, 4, 8, 16, 32 or 64 bit fields, each field containing a rotated run of non-zero bits, encoded in the "imm13" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV 64;
bits(VL) operand = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(64) element1 = Elem[operand, e, 64];
    Elem[result, e, 64] = element1 AND imm;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

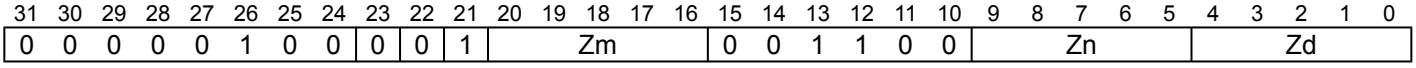
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

AND (vectors, unpredicated)

Bitwise AND vectors (unpredicated).

Bitwise AND all elements of the second source vector with corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE

```
AND <Zd>.D, <Zn>.D, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];

Z[d] = operand1 AND operand2;
```

Operational information

If PSTATE.DIT is 1:

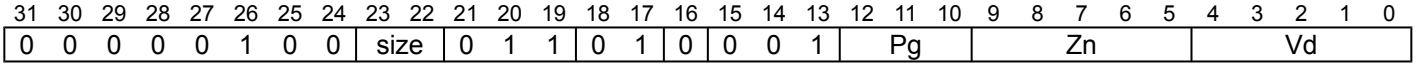
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ANDV

Bitwise AND reduction to scalar.

Bitwise AND horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as all ones.



SVE

```
ANDV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(esize) result = Ones(esize);

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        result = result AND Elem[operand, e, esize];

V[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

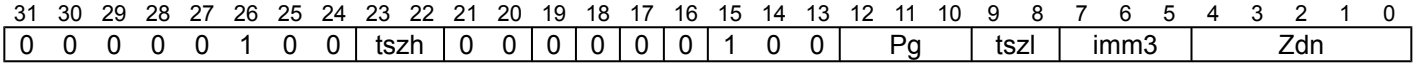
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ASR (immediate, predicated)

Arithmetic shift right by immediate (predicated).

Shift right by immediate, preserving the sign bit, each active element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. Inactive elements in the destination vector register remain unmodified.



SVE

```
ASR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = ASR(element1, shift);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

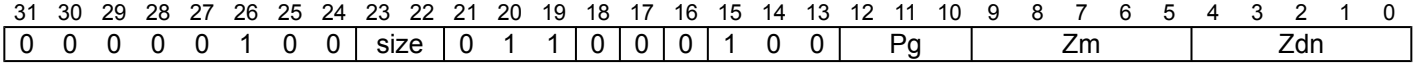
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ASR (wide elements, predicated)

Arithmetic shift right by 64-bit wide elements (predicated).

Shift right, preserving the sign bit, active elements of the first source vector by corresponding overlapping 64-bit elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount is a vector of unsigned 64-bit doubleword elements in which all bits are significant, and not used modulo the destination element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
ASR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(64) element2 = integer element2 = UInt(Elem[operand2, (e * esize) DIV 64, 64];
    integer shift = Min(UInt(element2), esize);
[operand2, (e * esize) DIV 64, 64]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = ASR(element1, shift);
(element1, element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and destination element size as this instruction.

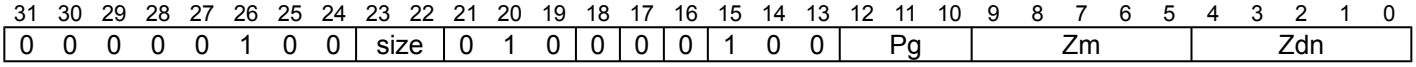
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ASR (vectors)

Arithmetic shift right by vector (predicated).

Shift right, preserving the sign bit, active elements of the first source vector by corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount operand is a vector of unsigned elements in which all bits are significant, and not used modulo the element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
ASR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = integer element2 = UInt(Elem[operand2, e, esize];
    integer shift = Min(UInt(element2), esize);
[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = ASR(element1, shift);
(element1, element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

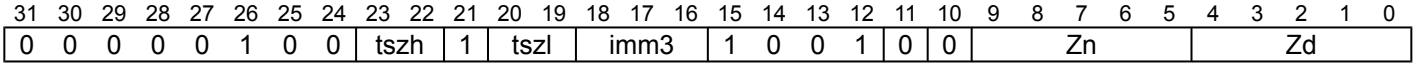
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ASR (immediate, unpredicated)

Arithmetic shift right by immediate (unpredicated).

Shift right by immediate, preserving the sign bit, each element of the source vector, and place the results in the corresponding elements of the destination vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE

```
ASR <Zd>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    Elem[result, e, esize] = ASR(element1, shift);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

- The values of the data supplied in any of its registers.
- The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

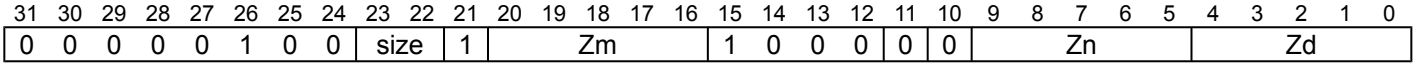
(old) htmldiff from- (new)

(old) htmldiff from- (new)

ASR (wide elements, unpredicated)

Arithmetic shift right by 64-bit wide elements (unpredicated).

Shift right, preserving the sign bit, all elements of the first source vector by corresponding overlapping 64-bit elements of the second source vector and place the first in the corresponding elements of the destination vector. The shift amount is a vector of unsigned 64-bit doubleword elements in which all bits are significant, and not used modulo the destination element size. This instruction is unpredicated.



SVE

```
ASR <Zd>.<T>, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(64) element2 = integer element2 = UInt(Elem[operand2, (e * esize) DIV 64, 64];
    integer shift = Min(UInt(element2), esize);[operand2, (e * esize) DIV 64, 64]);
    Elem[result, e, esize] = ASR(element1, shift);(element1, element2);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

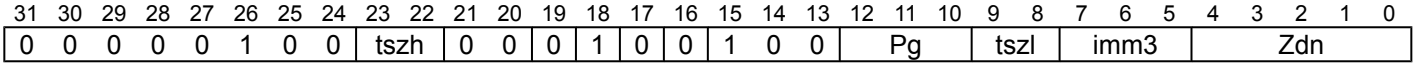
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

ASRD

Arithmetic shift right for divide by immediate (predicated).

Shift right by immediate, preserving the sign bit, each active element of the source vector, and destructively place the results in the corresponding elements of the source vector. The result rounds toward zero as in a signed division. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. Inactive elements in the destination vector register remain unmodified.



SVE

```
ASRD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        if element1 < 0 then
            element1 = element1 + ((1 << shift) - 1);
        Elem[result, e, esize] = (element1 >> shift)<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

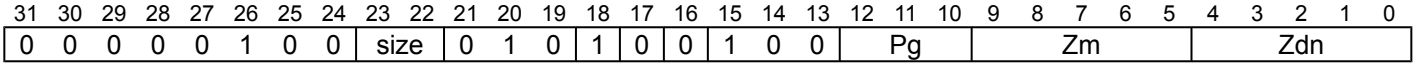
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ASRR

Reversed arithmetic shift right by vector (predicated).

Reversed shift right, preserving the sign bit, active elements of the second source vector by corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount operand is a vector of unsigned elements in which all bits are significant, and not used modulo the element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
ASRR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 =     integer element1 = UInt(Elem[operand1, e, esize];
[operand1, e, esize]);
    bits(esize) element2 = Elem[operand2, e, esize];
    integer shift = Min(UInt(element1), esize);
[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = ASR(element2, shift);
(element2, element1);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

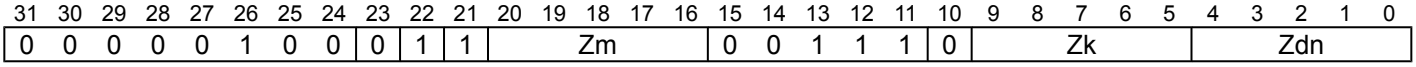
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

BCAX

Bitwise clear and exclusive OR.

Bitwise AND elements of the second source vector with the corresponding inverted elements of the third source vector, then exclusive OR the results with corresponding elements of the first source vector. The final results are destructively placed in the corresponding elements of the destination and first source vector. This instruction is unpredicated.



SVE2

```
BCAX <Zdn>.D, <Zdn>.D, <Zm>.D, <Zk>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer m = UInt(Zm);
integer k = UInt(Zk);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<Zk>	Is the name of the third source scalable vector register, encoded in the "Zk" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[k];

Z[dn] = operand1 EOR (operand2 AND NOT(operand3));
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

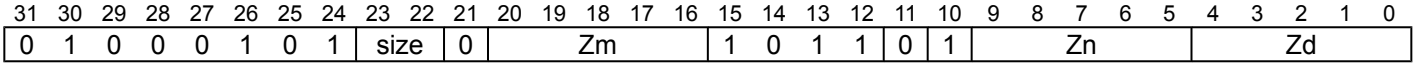
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

BDEP

Scatter lower bits into positions selected by bitmask.

This optional instruction scatters the lowest-numbered contiguous bits within each element of the first source vector to the bit positions indicated by non-zero bits in the corresponding mask element of the second source vector, preserving their order, and set the bits corresponding to a zero mask bit to zero. This instruction is unpredicated.



SVE2

```
BDEP <Zd>.<T>, <Zn>.<T>, <Zm>.<T>

if !HaveSVE2BitPerm() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) data = Z[n];
bits(VL) mask = Z[m];
bits(VL) result;

for e = 0 to elements - 1
    Elem[result, e, esize] = BitDeposit(Elem[data, e, esize], Elem[mask, e, esize]);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

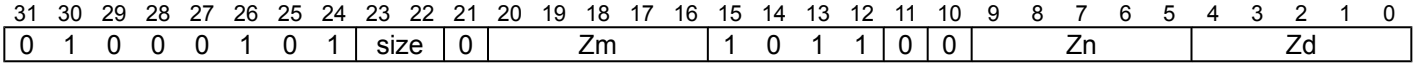
(old) htmldiff from- (new)

(old) htmldiff from- (new)

BEXT

Gather lower bits from positions selected by bitmask.

This optional instruction gathers bits in each element of the first source vector from the bit positions indicated by non-zero bits in the corresponding mask element of the second source vector to the lowest-numbered contiguous bits of the corresponding destination element, preserving their order, and sets the remaining higher-numbered bits to zero. This instruction is unpredicated.



SVE2

```
BEXT <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2BitPerm() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) data = Z[n];
bits(VL) mask = Z[m];
bits(VL) result;

for e = 0 to elements - 1
    Elem[result, e, esize] = BitExtract(Elem[data, e, esize], Elem[mask, e, esize]);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

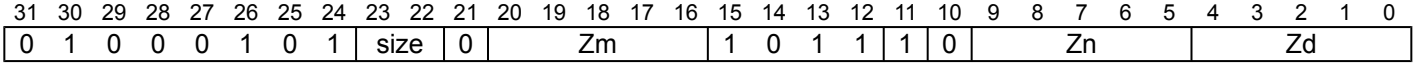
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

BGRP

Group bits to right or left as selected by bitmask.

This optional instruction separates bits in each element of the first source vector by gathering from the bit positions indicated by non-zero bits in the corresponding mask element of the second source vector to the lowest-numbered contiguous bits of the corresponding destination element, and from positions indicated by zero bits to the highest-numbered bits of the destination element, preserving the bit order within each group. This instruction is unpredicated.



SVE2

```
BGRP <Zd>.<T>, <Zn>.<T>, <Zm>.<T>

if !HaveSVE2BitPerm() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) data = Z[n];
bits(VL) mask = Z[m];
bits(VL) result;

for e = 0 to elements - 1
    Elem[result, e, esize] = BitGroup(Elem[data, e, esize], Elem[mask, e, esize]);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

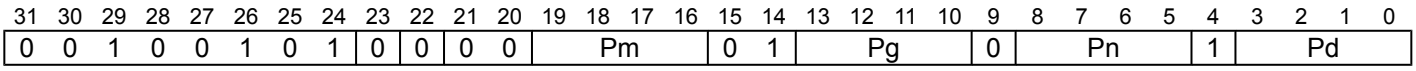
BIC, BICS (predicates)

Bitwise clear predicates.

Bitwise AND inverted active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

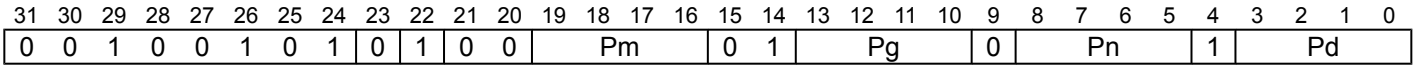


Not setting the condition flags

```
BIC <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
BICS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = element1 AND (NOT element2);
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

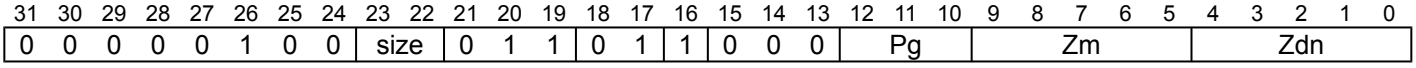
(old) htmldiff from- (new)

(old) htmldiff from- (new)

BIC (vectors, predicated)

Bitwise clear vectors (predicated).

Bitwise AND inverted active elements of the second source vector with corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
BIC <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1 AND (NOT element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

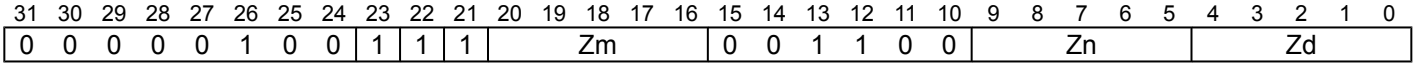
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

BIC (vectors, unpredicated)

Bitwise clear vectors (unpredicated).

Bitwise AND inverted all elements of the second source vector with corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE

```
BIC <Zd>.D, <Zn>.D, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];

Z[d] = operand1 AND (NOT operand2);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

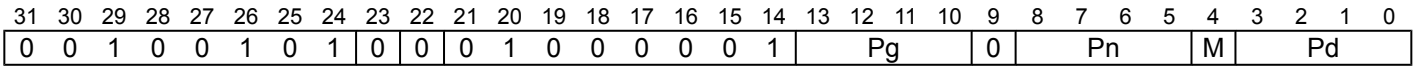
BRKA, BRKAS

Break after first true condition.

Sets destination predicate elements up to and including the first active and true source element to true, then sets subsequent elements to false. Inactive elements in the destination predicate register remain unmodified or are set to zero, depending on whether merging or zeroing predication is selected. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

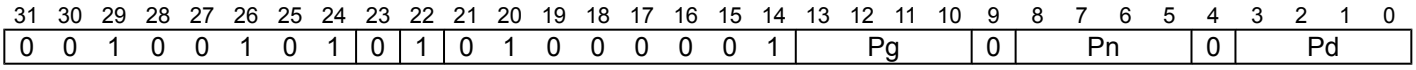


Not setting the condition flags

```
BRKA <Pd>.B, <Pg>/<ZM>, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer d = UInt(Pd);
boolean merging = (M == '1');
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
BRKAS <Pd>.B, <Pg>/Z, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer d = UInt(Pd);
boolean merging = FALSE;
boolean setflags = TRUE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<ZM> Is the predication qualifier, encoded in “M”:

M	<ZM>
0	Z
1	M

<Pn> Is the name of the source scalable predicate register, encoded in the "Pn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand  = P[n];
bits(PL) operand2 = P[d];
boolean break = FALSE;
bits(PL) result;

for e = 0 to elements-1
    boolean element = ElemP[operand, e, esize] == '1';
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = if !break then '1' else '0';
        break = break || element;
    elsif merging then
        ElemP[result, e, esize] = ElemP[operand2, e, esize];
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

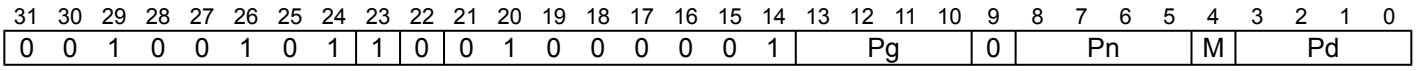
BRKB, BRKBS

Break before first true condition.

Sets destination predicate elements up to but not including the first active and true source element to true, then sets subsequent elements to false. Inactive elements in the destination predicate register remain unmodified or are set to zero, depending on whether merging or zeroing predication is selected. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

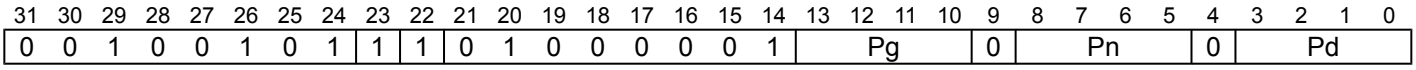


Not setting the condition flags

```
BRKB <Pd>.B, <Pg>/<ZM>, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer d = UInt(Pd);
boolean merging = (M == '1');
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
BRKBS <Pd>.B, <Pg>/Z, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer d = UInt(Pd);
boolean merging = FALSE;
boolean setflags = TRUE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<ZM> Is the predication qualifier, encoded in “M”:

M	<ZM>
0	Z
1	M

<Pn> Is the name of the source scalable predicate register, encoded in the "Pn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand  = P[n];
bits(PL) operand2 = P[d];
boolean break = FALSE;
bits(PL) result;

for e = 0 to elements-1
    boolean element = ElemP[operand, e, esize] == '1';
    if ElemP[mask, e, esize] == '1' then
        break = break || element;
        ElemP[result, e, esize] = if !break then '1' else '0';
    elsif merging then
        ElemP[result, e, esize] = ElemP[operand2, e, esize];
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

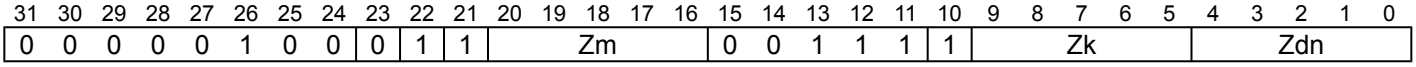
- The execution time of this instruction is independent of:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

BSL1N

Bitwise select with first input inverted.

Selects bits from the inverted first source vector where the corresponding bit in the third source vector is '1', and from the second source vector where the corresponding bit in the third source vector is '0'. The result is placed destructively in the destination and first source vector. This instruction is unpredicated.



SVE2

```
BSL1N <Zdn>.D, <Zdn>.D, <Zm>.D, <Zk>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer m = UInt(Zm);
integer k = UInt(Zk);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<Zk>	Is the name of the third source scalable vector register, encoded in the "Zk" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[k];

Z[dn] = (NOT(operand1) AND operand3) OR (operand2 AND NOT(operand3));
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

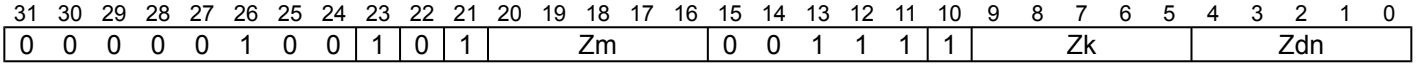
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

BSL2N

Bitwise select with second input inverted.

Selects bits from the first source vector where the corresponding bit in the third source vector is '1', and from the inverted second source vector where the corresponding bit in the third source vector is '0'. The result is placed destructively in the destination and first source vector. This instruction is unpredicated.



SVE2

```
BSL2N <Zdn>.D, <Zdn>.D, <Zm>.D, <Zk>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer m = UInt(Zm);
integer k = UInt(Zk);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<Zk>	Is the name of the third source scalable vector register, encoded in the "Zk" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[k];

Z[dn] = (operand1 AND operand3) OR (NOT(operand2) AND NOT(operand3));
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

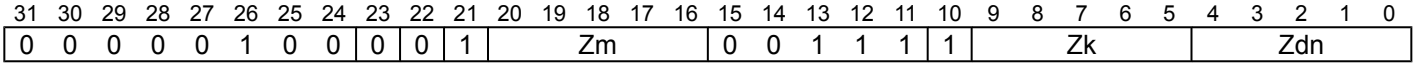
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

BSL

Bitwise select.

Selects bits from the first source vector where the corresponding bit in the third source vector is '1', and from the second source vector where the corresponding bit in the third source vector is '0'. The result is placed destructively in the destination and first source vector. This instruction is unpredicated.



SVE2

```
BSL <Zdn>.D, <Zdn>.D, <Zm>.D, <Zk>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer m = UInt(Zm);
integer k = UInt(Zk);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<Zk>	Is the name of the third source scalable vector register, encoded in the "Zk" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[k];

Z[dn] = (operand1 AND operand3) OR (operand2 AND NOT(operand3));
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

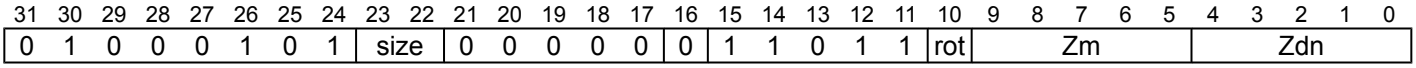
(old) htmldiff from- (new)

CADD

Complex integer add with rotate.

Add the real and imaginary components of the integral complex numbers from the first source vector to the complex numbers from the second source vector which have first been rotated by 90 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation, equivalent to multiplying the complex numbers in the second source vector by ±i beforehand. Destructively place the results in the corresponding elements of the first source vector. This instruction is unpredicated.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.



SVE2

```
CADD <Zdn>.<T>, <Zdn>.<T>, <Zm>.<T>, <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
boolean sub_i = (rot == '0');
boolean sub_r = (rot == '1');
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
0	#90
1	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for p = 0 to pairs-1
    integer acc_r  = SInt(Elem[operand1, 2 * p + 0, esize]);
    integer acc_i  = SInt(Elem[operand1, 2 * p + 1, esize]);
    integer elt2_r = SInt(Elem[operand2, 2 * p + 0, esize]);
    integer elt2_i = SInt(Elem[operand2, 2 * p + 1, esize]);
    if sub_i then
        acc_r = acc_r - elt2_i;
        acc_i = acc_i + elt2_r;
    if sub_r then
        acc_r = acc_r + elt2_i;
        acc_i = acc_i - elt2_r;

    Elem[result, 2 * p + 0, esize] = acc_r<esize-1:0>;
    Elem[result, 2 * p + 1, esize] = acc_i<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CDOT (vectors)

Complex integer dot product.

The complex integer dot product instructions delimit the source vectors into pairs of 8-bit or 16-bit signed integer complex numbers. Within each pair, the complex numbers in the first source vector are multiplied by the corresponding complex numbers in the second source vector and the resulting wide real or wide imaginary part of the product is accumulated into a 32-bit or 64-bit destination vector element which overlaps all four of the elements that comprise a pair of complex number values in the first source vector.

As a result each instruction implicitly deinterleaves the real and imaginary components of their complex number inputs, so that the destination vector accumulates 4×wide real sums or 4×wide imaginary sums.

The complex numbers in the second source vector are rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation, by performing the following transformations prior to the dot product operations:

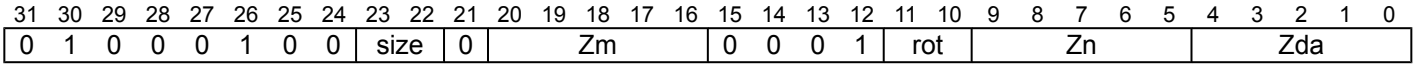
* If the rotation is #0, the imaginary parts of the complex numbers in the second source vector are negated. The destination vector therefore accumulates the real parts of a complex dot product.

* If the rotation is #90, the real and imaginary parts of the complex numbers the second source vector are swapped. The destination vector therefore accumulates the imaginary parts of a complex dot product.

* If the rotation is #180, there is no transformation. The destination vector therefore accumulates the real parts of a complex conjugate dot product.

* If the rotation is #270, the real parts of the complex numbers in the second source vector are negated and then swapped with the imaginary parts. The destination vector therefore accumulates the imaginary parts of a complex conjugate dot product.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.



SVE2

```
CDOT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>, <const>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_i = (rot<0> == rot<1>);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size<0>”:

size<0>	<Tb>
0	B
1	H

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) res = Elem[operand3, e, esize];
    for i = 0 to 1
        integer elt1_r = SInt(Elem[operand1, 4 * e + 2 * i + 0, esize DIV 4]);
        integer elt1_i = SInt(Elem[operand1, 4 * e + 2 * i + 1, esize DIV 4]);
        integer elt2_a = SInt(Elem[operand2, 4 * e + 2 * i + sel_a, esize DIV 4]);
        integer elt2_b = SInt(Elem[operand2, 4 * e + 2 * i + sel_b, esize DIV 4]);
        if sub_i then
            res = res + (elt1_r * elt2_a) - (elt1_i * elt2_b);
        else
            res = res + (elt1_r * elt2_a) + (elt1_i * elt2_b);
    Elem[result, e, esize] = res;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

CDOT (indexed)

Complex integer dot product (indexed).

The complex integer dot product instructions delimit the source vectors into pairs of 8-bit or 16-bit signed integer complex numbers. Within each pair, the complex numbers in the first source vector are multiplied by the corresponding complex numbers in the second source vector and the resulting wide real or wide imaginary part of the product is accumulated into a 32-bit or 64-bit destination vector element which overlaps all four of the elements that comprise a pair of complex number values in the first source vector.

As a result each instruction implicitly deinterleaves the real and imaginary components of their complex number inputs, so that the destination vector accumulates 4×wide real sums or 4×wide imaginary sums.

The complex numbers in the second source vector are rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation, by performing the following transformations prior to the dot product operations:

* If the rotation is #0, the imaginary parts of the complex numbers in the second source vector are negated. The destination vector therefore accumulates the real parts of a complex dot product.

* If the rotation is #90, the real and imaginary parts of the complex numbers the second source vector are swapped. The destination vector therefore accumulates the imaginary parts of a complex dot product.

* If the rotation is #180, there is no transformation. The destination vector therefore accumulates the real parts of a complex conjugate dot product.

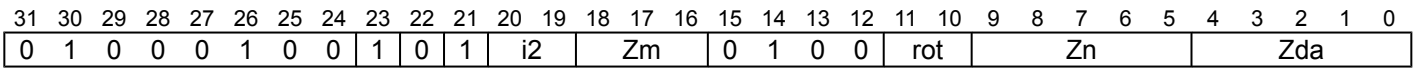
* If the rotation is #270, the real parts of the complex numbers in the second source vector are negated and then swapped with the imaginary parts. The destination vector therefore accumulates the imaginary parts of a complex conjugate dot product.

The indexed form of these instructions select a single pair of complex numbers within each 128-bit segment of the second source vector as the multiplier for all pairs of complex numbers within the corresponding 128-bit segment of the first source vector. The complex number pairs within the second source vector are specified using an immediate index which selects the same complex number pair position within each 128-bit vector segment. The index range is from 0 to one less than the number of complex number pairs per 128-bit segment, encoded in 1 or 2 bits depending on the size of the complex number pair.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

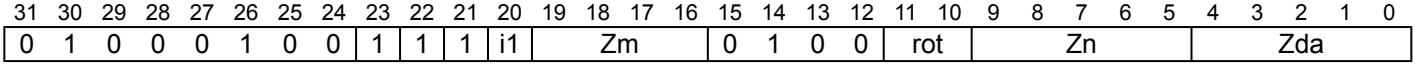


32-bit

```
CDOT <Zda>.S, <Zn>.B, <Zm>.B[<imm>], <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_i = (rot<0> == rot<1>);
```

64-bit



64-bit

```
CDOT <Zda>.D, <Zn>.H, <Zm>.H[<imm>], <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_i = (rot<0> == rot<1>);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.

For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.

<imm> For the 32-bit variant: is the immediate index of a quadtuplet of four 8-bit elements within each 128-bit vector segment, in the range 0 to 3, encoded in the "i2" field.

For the 64-bit variant: is the immediate index of a quadtuplet of four 16-bit elements within each 128-bit vector segment, in the range 0 to 1, encoded in the "i1" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    bits(esize) res = Elem[operand3, e, esize];
    for i = 0 to 1
        integer elt1_r = SInt(Elem[operand1, 4 * e + 2 * i + 0, esize DIV 4]);
        integer elt1_i = SInt(Elem[operand1, 4 * e + 2 * i + 1, esize DIV 4]);
        integer elt2_a = SInt(Elem[operand2, 4 * s + 2 * i + sel_a, esize DIV 4]);
        integer elt2_b = SInt(Elem[operand2, 4 * s + 2 * i + sel_b, esize DIV 4]);
        if sub_i then
            res = res + (elt1_r * elt2_a) - (elt1_i * elt2_b);
        else
            res = res + (elt1_r * elt2_a) + (elt1_i * elt2_b);
    Elem[result, e, esize] = res;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
    - The values of the data supplied in any of its registers.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

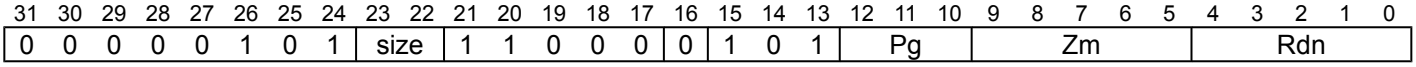
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

CLASTA (scalar)

Conditionally extract element after last to general-purpose register.

From the source vector register extract the element after the last active element, or if the last active element is the final element extract element zero, and then zero-extend that element to destructively place in the destination and first source general-purpose register. If there are no active elements then destructively zero-extend the least significant element-size bits of the destination and first source general-purpose register.



SVE

```
CLASTA <R><dn>, <Pg>, <R><dn>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Rdn);
integer m = UInt(Zm);
integer csize = if esize < 64 then 32 else 64;
boolean isBefore = FALSE;
```

Assembler Symbols

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<dn> Is the number [0-30] of the source and destination general-purpose register or the name ZR (31), encoded in the "Rdn" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the source scalable vector register, encoded in the "Zm" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(esize) operand1 = X[dn];
bits(VL) operand2 = Z[m];
bits(csize) result;
integer last = LastActiveElement(mask, esize);

if last < 0 then
    result = ZeroExtend(operand1);
else
    if !isBefore then
        last = last + 1;
        if last >= elements then last = 0;
    result = ZeroExtend(Elem[operand2, last, esize]);

X[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

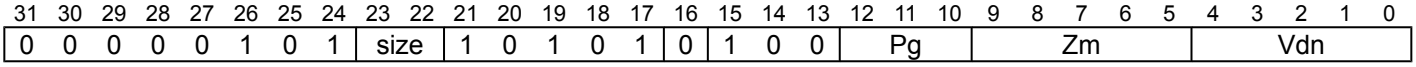
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CLASTA (SIMD&FP scalar)

Conditionally extract element after last to SIMD&FP scalar register.

From the source vector register extract the element after the last active element, or if the last active element is the final element extract element zero, and then zero-extend that element to destructively place in the destination and first source SIMD & floating-point scalar register. If there are no active elements then destructively zero-extend the least significant element-size bits of the destination and first source SIMD & floating-point scalar register.



SVE

```
CLASTA <V><dn>, <Pg>, <V><dn>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Vdn);
integer m = UInt(Zm);
boolean isBefore = FALSE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<dn> Is the number [0-31] of the source and destination SIMD&FP register, encoded in the "Vdn" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the source scalable vector register, encoded in the "Zm" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(esize) operand1 = V[dn];
bits(VL) operand2 = Z[m];
bits(esize) result;
integer last = LastActiveElement(mask, esize);

if last < 0 then
    result = ZeroExtend(operand1);
else
    if !isBefore then
        last = last + 1;
        if last >= elements then last = 0;
    result = Elem[operand2, last, esize];

V[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

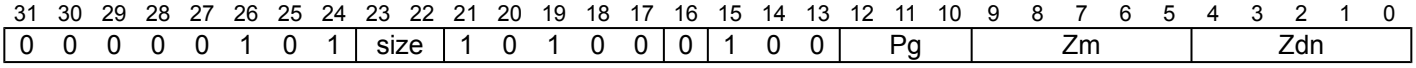
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CLASTA (vectors)

Conditionally extract element after last to vector register.

From the second source vector register extract the element after the last active element, or if the last active element is the final element extract element zero, and then replicate that element to destructively fill the destination and first source vector.
If there are no active elements then leave the destination and source vector unmodified.



SVE

```
CLASTA <Zdn>.<T>, <Pg>, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean isBefore = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer last = LastActiveElement(mask, esize);

if last < 0 then
    result = operand1;
else
    if !isBefore then
        last = last + 1;
        if last >= elements then last = 0;
    for e = 0 to elements-1
        Elem[result, e, esize] = Elem[operand2, last, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

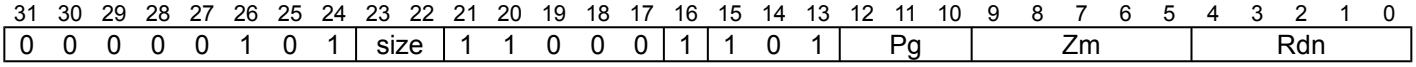
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CLASTB (scalar)

Conditionally extract last element to general-purpose register.

From the source vector register extract the last active element, and then zero-extend that element to destructively place in the destination and first source general-purpose register. If there are no active elements then destructively zero-extend the least significant element-size bits of the destination and first source general-purpose register.



SVE

```
CLASTB <R><dn>, <Pg>, <R><dn>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Rdn);
integer m = UInt(Zm);
integer csize = if esize < 64 then 32 else 64;
boolean isBefore = TRUE;
```

Assembler Symbols

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<dn> Is the number [0-30] of the source and destination general-purpose register or the name ZR (31), encoded in the "Rdn" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the source scalable vector register, encoded in the "Zm" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(esize) operand1 = X[dn];
bits(VL) operand2 = Z[m];
bits(csize) result;
integer last = LastActiveElement(mask, esize);

if last < 0 then
    result = ZeroExtend(operand1);
else
    if !isBefore then
        last = last + 1;
        if last >= elements then last = 0;
    result = ZeroExtend(Elem[operand2, last, esize]);

X[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

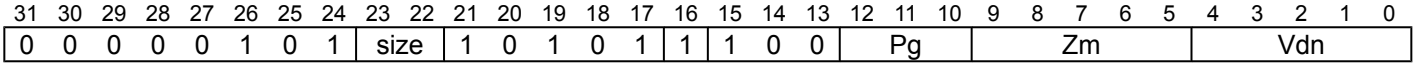
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CLASTB (SIMD&FP scalar)

Conditionally extract last element to SIMD&FP scalar register.

From the source vector register extract the last active element, and then zero-extend that element to destructively place in the destination and first source SIMD & floating-point scalar register. If there are no active elements then destructively zero-extend the least significant element-size bits of the destination and first source SIMD & floating-point scalar register.



SVE

```
CLASTB <V><dn>, <Pg>, <V><dn>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Vdn);
integer m = UInt(Zm);
boolean isBefore = TRUE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<dn> Is the number [0-31] of the source and destination SIMD&FP register, encoded in the "Vdn" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the source scalable vector register, encoded in the "Zm" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(esize) operand1 = V[dn];
bits(VL) operand2 = Z[m];
bits(esize) result;
integer last = LastActiveElement(mask, esize);

if last < 0 then
    result = ZeroExtend(operand1);
else
    if !isBefore then
        last = last + 1;
        if last >= elements then last = 0;
    result = Elem[operand2, last, esize];

V[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

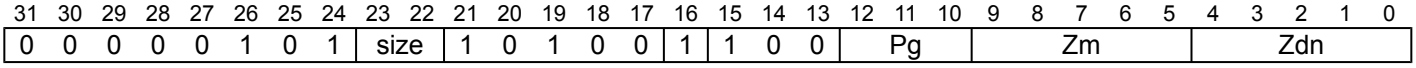
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CLASTB (vectors)

Conditionally extract last element to vector register.

From the second source vector register extract the last active element, and then replicate that element to destructively fill the destination and first source vector.
If there are no active elements then leave the destination and source vector unmodified.



SVE

```
CLASTB <Zdn>.<T>, <Pg>, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean isBefore = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer last = LastActiveElement(mask, esize);

if last < 0 then
    result = operand1;
else
    if !isBefore then
        last = last + 1;
        if last >= elements then last = 0;
    for e = 0 to elements-1
        Elem[result, e, esize] = Elem[operand2, last, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

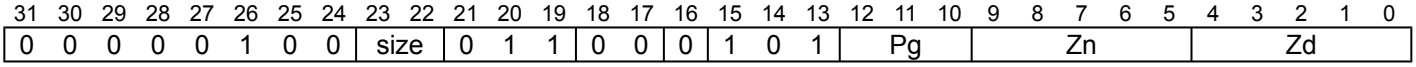
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

CLS

Count leading sign bits (predicated).

Count leading sign bits in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
CLS <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = CountLeadingSignBits(element)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

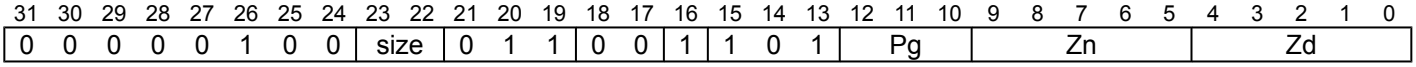
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CLZ

Count leading zero bits (predicated).

Count leading zero bits in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
CLZ <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = CountLeadingZeroBits(element)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CMLA (vectors)

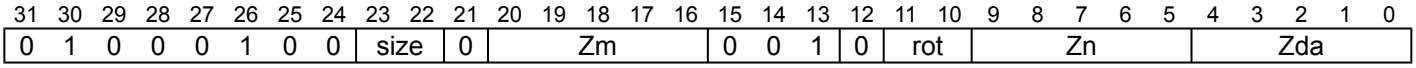
Complex integer multiply-add with rotate.

Multiply the duplicated real components for rotations 0 and 180, or imaginary components for rotations 90 and 270, of the integral numbers in the first source vector by the corresponding complex number in the second source vector rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation.

Then add the products to the corresponding components of the complex numbers in the addend vector. Destructively place the results in the corresponding elements of the addend vector. This instruction is unpredicated.

These transformations permit the creation of a variety of multiply-add and multiply-subtract operations on complex numbers by combining two of these instructions with the same vector operands but with rotations that are 90 degrees apart.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.



SVE2

```
CMLA <Zda>.<T>, <Zn>.<T>, <Zm>.<T>, <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_r = (rot<0> != rot<1>);
boolean sub_i = (rot<1> == '1');
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for p = 0 to pairs-1
    integer elt1_a = SInt(Elem[operand1, 2 * p + sel_a, esize]);
    integer elt2_a = SInt(Elem[operand2, 2 * p + sel_a, esize]);
    integer elt2_b = SInt(Elem[operand2, 2 * p + sel_b, esize]);
    bits(esize) elt3_r = Elem[operand3, 2 * p + 0, esize];
    bits(esize) elt3_i = Elem[operand3, 2 * p + 1, esize];
    integer product_r =  elt1_a * elt2_a;
    integer product_i =  elt1_a * elt2_b;
    if sub_r then
        Elem[result, 2 * p + 0, esize] = elt3_r - product_r;
    else
        Elem[result, 2 * p + 0, esize] = elt3_r + product_r;
    if sub_i then
        Elem[result, 2 * p + 1, esize] = elt3_i - product_i;
    else
        Elem[result, 2 * p + 1, esize] = elt3_i + product_i;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CMLA (indexed)

Complex integer multiply-add with rotate (indexed).

Multiply the duplicated real components for rotations 0 and 180, or imaginary components for rotations 90 and 270, of the integral numbers in each 128-bit segment of the first source vector by the specified complex number in the corresponding the second source vector segment rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation.

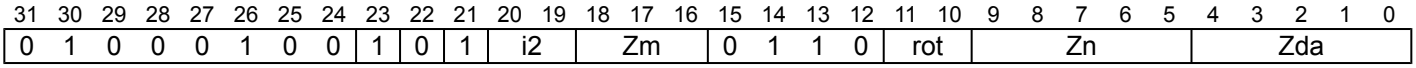
Then add the products to the corresponding components of the complex numbers in the addend vector. Destructively place the results in the corresponding elements of the addend vector. This instruction is unpredicated.

These transformations permit the creation of a variety of multiply-add and multiply-subtract operations on complex numbers by combining two of these instructions with the same vector operands but with rotations that are 90 degrees apart.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.

It has encodings from 2 classes: 16-bit and 32-bit

16-bit

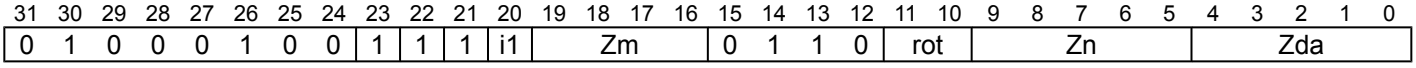


16-bit

```
CMLA <Zda>.H, <Zn>.H, <Zm>.H[<imm>], <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_r = (rot<0> != rot<1>);
boolean sub_i = (rot<1> == '1');
```

32-bit



32-bit

```
CMLA <Zda>.S, <Zn>.S, <Zm>.S[<imm>], <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_r = (rot<0> != rot<1>);
boolean sub_i = (rot<1> == '1');
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> For the 16-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.

For the 32-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.

<imm> For the 16-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field.

For the 32-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
integer pairspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for p = 0 to pairs-1
    integer segmentbase = p - p MOD pairspersegment;
    integer s = segmentbase + index;
    integer elt1_a = SInt(Elem[operand1, 2 * p + sel_a, esize]);
    integer elt2_a = SInt(Elem[operand2, 2 * s + sel_a, esize]);
    integer elt2_b = SInt(Elem[operand2, 2 * s + sel_b, esize]);
    bits(esize) elt3_r = Elem[operand3, 2 * p + 0, esize];
    bits(esize) elt3_i = Elem[operand3, 2 * p + 1, esize];
    integer product_r =  elt1_a * elt2_a;
    integer product_i =  elt1_a * elt2_b;
    if sub_r then
        Elem[result, 2 * p + 0, esize] = elt3_r - product_r;
    else
        Elem[result, 2 * p + 0, esize] = elt3_r + product_r;
    if sub_i then
        Elem[result, 2 * p + 1, esize] = elt3_i - product_i;
    else
        Elem[result, 2 * p + 1, esize] = elt3_i + product_i;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

(old) htmldiff from- (new)

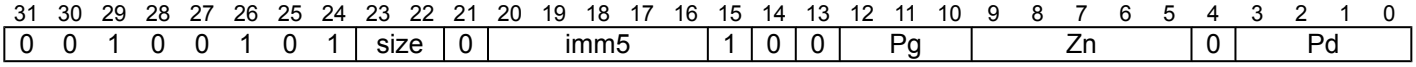
CMP<cc> (immediate)

Compare vector to immediate.

Compare active integer elements in the source vector with an immediate, and place the boolean results of the specified comparison in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.
The <cc> symbol specifies one of the standard ARM condition codes: EQ, GE, GT, HI, HS, LE, LO, LS, LT or NE.

It has encodings from 10 classes: Equal , Greater than , Greater than or equal , Higher , Higher or same , Less than , Less than or equal , Lower , Lower or same and Not equal

Equal

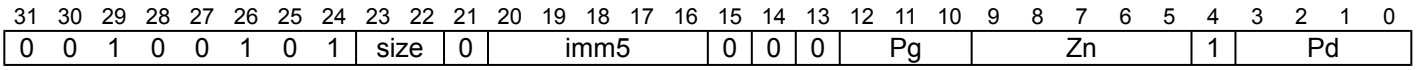


Equal

```
CMPEQ <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_EQ;
integer imm = SInt(imm5);
boolean unsigned = FALSE;
```

Greater than

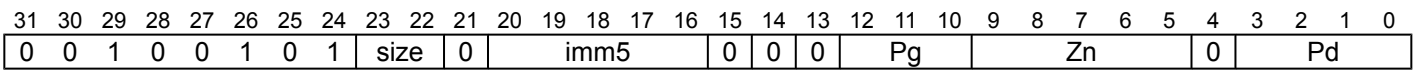


Greater than

```
CMPGT <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_GT;
integer imm = SInt(imm5);
boolean unsigned = FALSE;
```

Greater than or equal

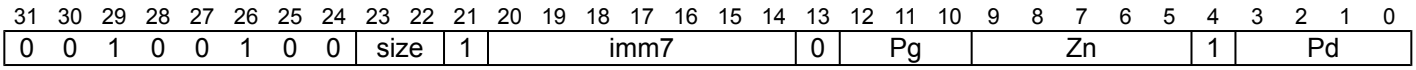


Greater than or equal

```
CMPGE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_GE;
integer imm = SInt(imm5);
boolean unsigned = FALSE;
```

Higher

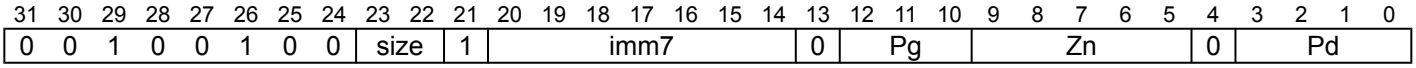


Higher

```
CMPHI <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_GT;
integer imm = UInt(imm7);
boolean unsigned = TRUE;
```

Higher or same

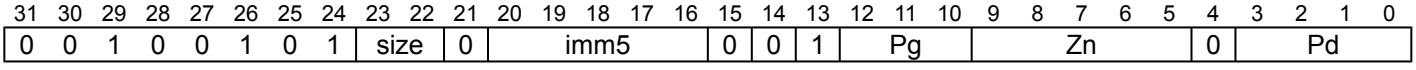


Higher or same

```
CMPHS <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_GE;
integer imm = UInt(imm7);
boolean unsigned = TRUE;
```

Less than

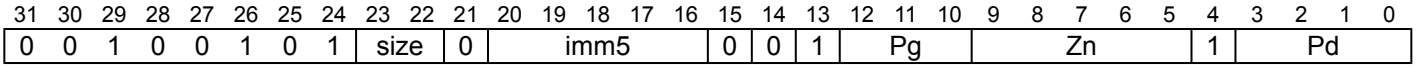


Less than

```
CMPLT <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_LT;
integer imm = SInt(imm5);
boolean unsigned = FALSE;
```

Less than or equal

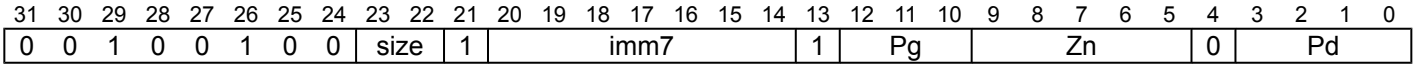


Less than or equal

```
CMPLE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_LE;
integer imm = SInt(imm5);
boolean unsigned = FALSE;
```

Lower

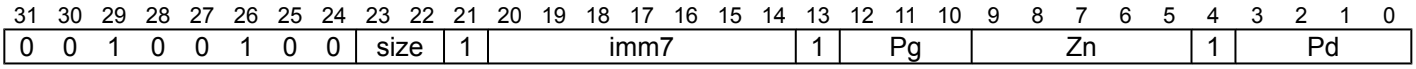


Lower

```
CMPLO <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_LT;
integer imm = UInt(imm7);
boolean unsigned = TRUE;
```

Lower or same

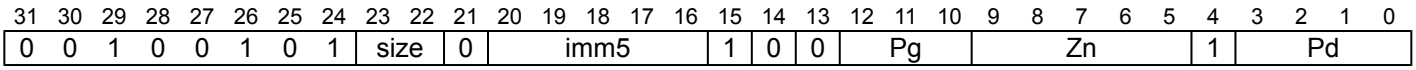


Lower or same

```
CMPLS <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_LE;
integer imm = UInt(imm7);
boolean unsigned = TRUE;
```

Not equal



Not equal

```
CMPNE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Pd);
SVECmp op = Cmp_NE;
integer imm = SInt(imm5);
boolean unsigned = FALSE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<imm> For the equal, greater than, greater than or equal, less than, less than or equal and not equal variant: is the signed immediate operand, in the range -16 to 15, encoded in the "imm5" field.

For the higher, higher or same, lower and lower or same variant: is the unsigned immediate operand, in the range 0 to 127, encoded in the "imm7" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(PL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        boolean cond;
        case op of
            when Cmp_EQ cond = element1 == imm;
            when Cmp_NE cond = element1 != imm;
            when Cmp_GE cond = element1 >= imm;
            when Cmp_LT cond = element1 <  imm;
            when Cmp_GT cond = element1 >  imm;
            when Cmp_LE cond = element1 <= imm;
        ElemP[result, e, esize] = if cond then '1' else '0';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ : Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

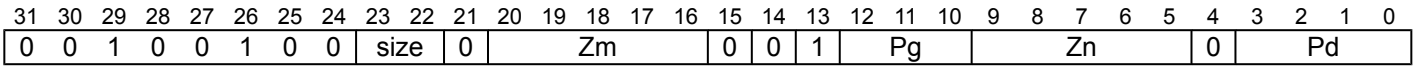
CMP<cc> (wide elements)

Compare vector to 64-bit wide elements.

Compare active integer elements in the first source vector with overlapping 64-bit doubleword elements in the second source vector, and place the boolean results of the specified comparison in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.
The <cc> symbol specifies one of the standard ARM condition codes: EQ, GE, GT, HI, HS, LE, LO, LS, LT or NE.

It has encodings from 10 classes: Equal , Greater than , Greater than or equal , Higher , Higher or same , Less than , Less than or equal , Lower , Lower or same and Not equal

Equal

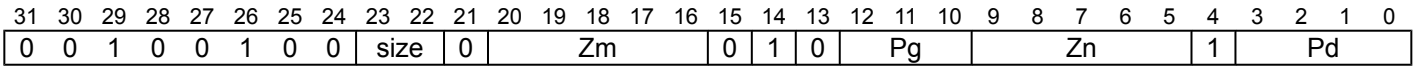


Equal

```
CMPEQ <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_EQ;
boolean unsigned = FALSE;
```

Greater than

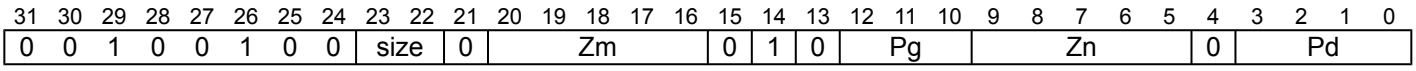


Greater than

```
CMPGT <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GT;
boolean unsigned = FALSE;
```

Greater than or equal

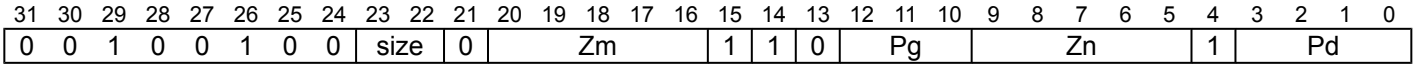


Greater than or equal

```
CMPGE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GE;
boolean unsigned = FALSE;
```

Higher

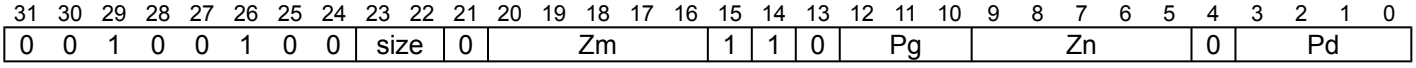


Higher

```
CMPHI <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GT;
boolean unsigned = TRUE;
```

Higher or same

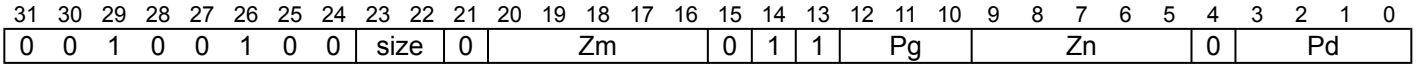


Higher or same

```
CMPHS <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GE;
boolean unsigned = TRUE;
```

Less than

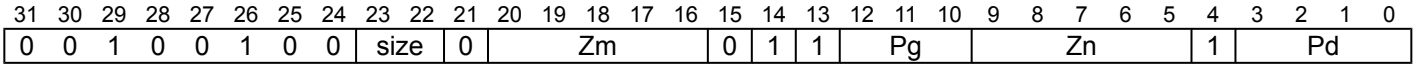


Less than

```
CMPLT <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_LT;
boolean unsigned = FALSE;
```

Less than or equal

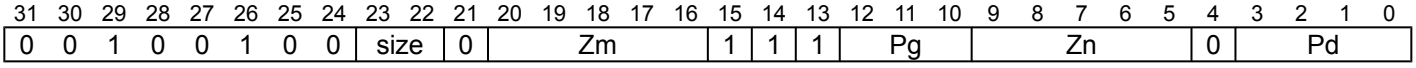


Less than or equal

```
CMPLE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_LE;
boolean unsigned = FALSE;
```

Lower

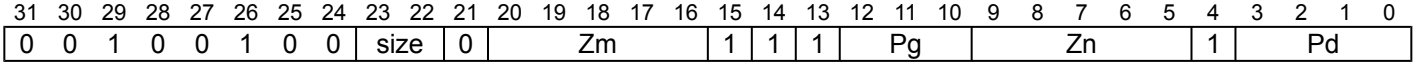


Lower

```
CMPLO <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_LT;
boolean unsigned = TRUE;
```

Lower or same

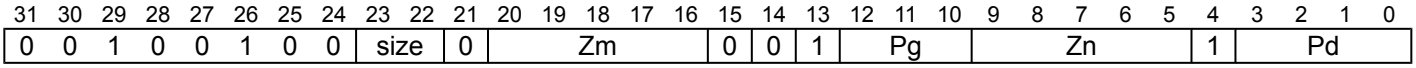


Lower or same

```
CMPLS <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_LE;
boolean unsigned = TRUE;
```

Not equal



Not equal

```
CMPNE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_NE;
boolean unsigned = FALSE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(PL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, (e * esize) DIV 64, 64], unsigned);
    if ElemP[mask, e, esize] == '1' then
        boolean cond;
        case op of
            when Cmp_EQ cond = element1 == element2;
            when Cmp_NE cond = element1 != element2;
            when Cmp_GE cond = element1 >= element2;
            when Cmp_LT cond = element1 <  element2;
            when Cmp_GT cond = element1 >  element2;
            when Cmp_LE cond = element1 <= element2;
        ElemP[result, e, esize] = if cond then '1' else '0';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

CMP<cc> (vectors)

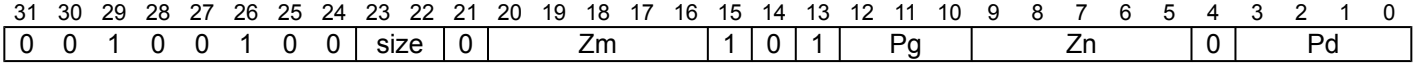
Compare vectors.

Compare active integer elements in the first source vector with corresponding elements in the second source vector, and place the boolean results of the specified comparison in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.
The <cc> symbol specifies one of the standard ARM condition codes: EQ, GE, GT, HI, HS or NE.

This instruction is used by the pseudo-instructions CMPLE (vectors), CMPLO (vectors), CMPLS (vectors), and CMPLT (vectors).

It has encodings from 6 classes: Equal , Greater than , Greater than or equal , Higher , Higher or same and Not equal

Equal

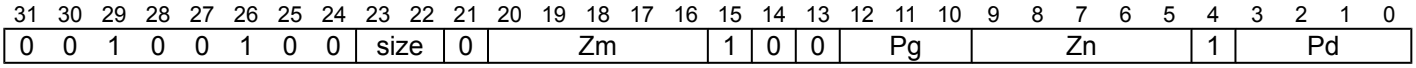


Equal

```
CMPEQ <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_EQ;
boolean unsigned = FALSE;
```

Greater than

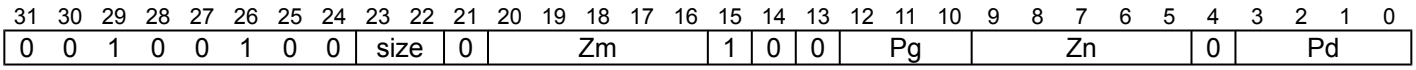


Greater than

```
CMPGT <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GT;
boolean unsigned = FALSE;
```

Greater than or equal

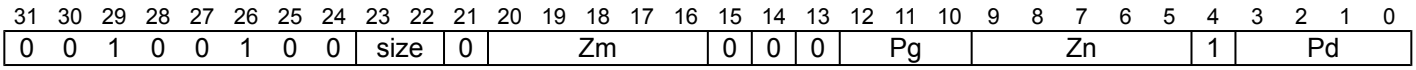


Greater than or equal

```
CMPGE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GE;
boolean unsigned = FALSE;
```

Higher

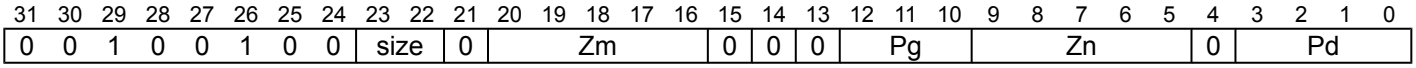


Higher

```
CMPHI <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GT;
boolean unsigned = TRUE;
```

Higher or same

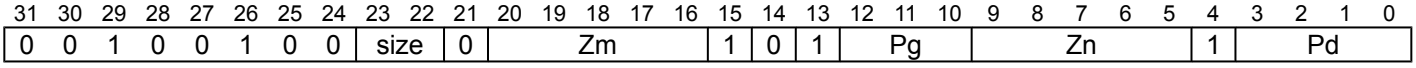


Higher or same

```
CMPHS <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_GE;
boolean unsigned = TRUE;
```

Not equal



Not equal

```
CMPNE <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Pd);
SVECmp op = Cmp_NE;
boolean unsigned = FALSE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(PL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        boolean cond;
        case op of
            when Cmp_EQ cond = element1 == element2;
            when Cmp_NE cond = element1 != element2;
            when Cmp_GE cond = element1 >= element2;
            when Cmp_LT cond = element1 <  element2;
            when Cmp_GT cond = element1 >  element2;
            when Cmp_LE cond = element1 <= element2;
        ElemP[result, e, esize] = if cond then '1' else '0';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

- The values of the NZCV flags.

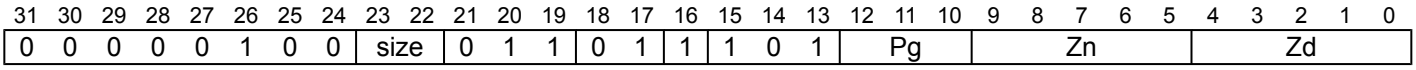
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

CNOT

Logically invert boolean condition in vector (predicated).

Logically invert the boolean value in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
Boolean TRUE is any non-zero value in a source, and one in a result element. Boolean FALSE is always zero.



SVE

```
CNOT <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = ZeroExtend(IsZeroBit(element), esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

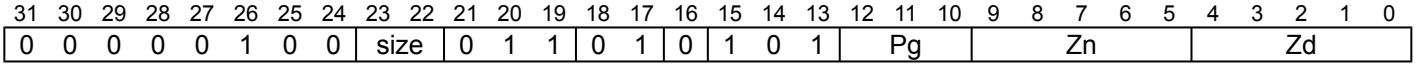
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CNT

Count non-zero bits (predicated).

Count non-zero bits in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
CNT <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = BitCount(element)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

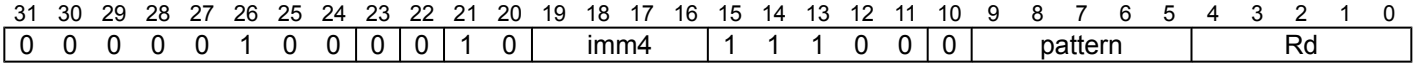
CNTB, CNTD, CNTH, CNTW

Set scalar to multiple of predicate constraint element count.

Determines the number of active elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then places the result in the scalar destination.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 4 classes: Byte , Doubleword , Halfword and Word

Byte

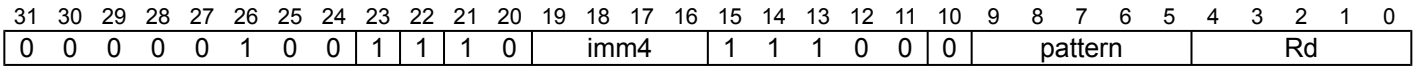


Byte

```
CNTB <Xd>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer d = UInt(Rd);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Doubleword

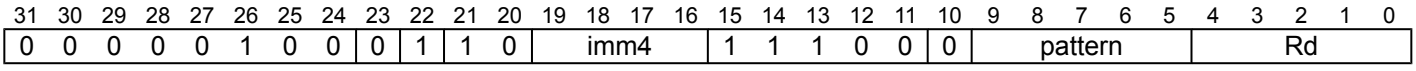


Doubleword

```
CNTD <Xd>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer d = UInt(Rd);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Halfword

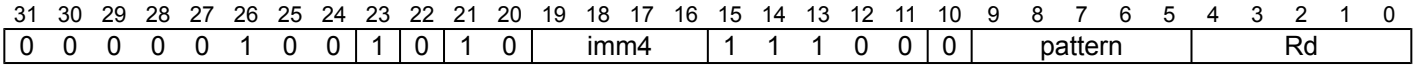


Halfword

```
CNTH <Xd>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer d = UInt(Rd);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Word



Word

```
CNTW <Xd>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer d = UInt(Rd);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Assembler Symbols

<Xd> Is the 64-bit name of the destination general-purpose register, encoded in the "Rd" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);

X[d] = (count * imm)<63:0>;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

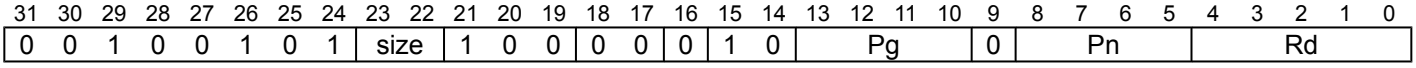
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

CNTP

Set scalar to countactive ofpredicate trueelement predicate elements.count.

Counts the number of active and true elements in the source predicate and places the scalar result in the destination general-purpose register. Inactive predicate elements are not counted.



SVE

```
CNTP <Xd>, <Pg>, <Pn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Pn);
integer d = UInt(Rd);
```

Assembler Symbols

<Xd> Is the 64-bit name of the destination general-purpose register, encoded in the "Rd" field.

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<Pn> Is the name of the source scalable predicate register, encoded in the "Pn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand = P[n];
bits(64) sum = Zeros();

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' && ElemP[operand, e, esize] == '1' then
        sum = sum + 1;
X[d] = sum;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

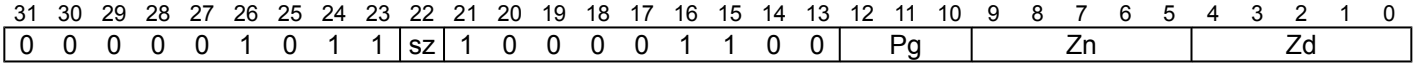
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

COMPACT

Shuffle active elements of vector to the right and fill with zero.

Read the active elements from the source vector and pack them into the lowest-numbered elements of the destination vector. Then set any remaining elements of the destination vector to zero.



SVE

```
COMPACT <Zd>.<T>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “sz”:

sz	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) result;
integer x = 0;

for e = 0 to elements-1
    Elem[result, e, esize] = Zeros();
    if ElemP[mask, e, esize] == '1' then
        bits(esize) element = Elem[operand1, e, esize];
        Elem[result, x, esize] = element;
        x = x + 1;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

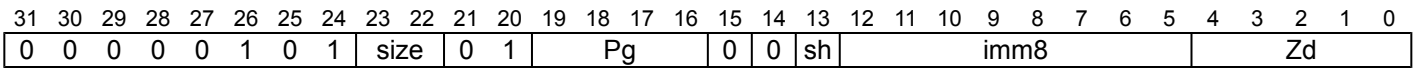
(old) htmldiff from- (new)

CPY (immediate, zeroing)

Copy signed integer immediate to vector elements (zeroing).

Copy a signed integer immediate to each active element in the destination vector. Inactive elements in the destination vector register are set to zero.
The immediate operand is a signed value in the range -128 to +127, and for element widths of 16 bits or higher it may also be a signed multiple of 256 in the range -32768 to +32512 (excluding 0).
The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<simm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".

This instruction is used by the alias MOV (immediate, predicated, zeroing).



SVE

```
CPY <Zd>.<T>, <Pg>/Z, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer d = UInt(Zd);
boolean merging = FALSE;
integer imm = SInt(imm8);
if sh == '1' then imm = imm << 8;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<imm> Is a signed immediate in the range -128 to 127, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) dest = Z[d];
bits(VL) result;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = imm<esize-1:0>;
    elsif merging then
        Elem[result, e, esize] = Elem[dest, e, esize];
    else
        Elem[result, e, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2, sve v2019-06_rc4 ; Build timestamp: 2019-06-26T22:04

(old) htmldiff from- (new)

CPY (immediate, merging)

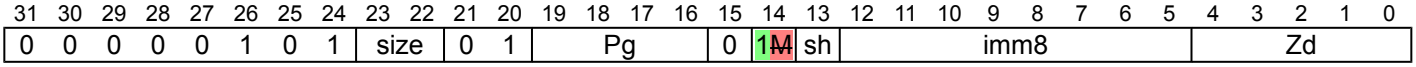
Copy signed integer immediate to vector elements (merging~~predicated~~).

Copy a signed integer immediate to each active element in the destination vector. Inactive elements in the destination vector register remain unmodified.~~unmodified or are set to zero, depending on whether merging or zeroing predication is selected.~~

The immediate operand is a signed value in the range -128 to +127, and for element widths of 16 bits or higher it may also be a signed multiple of 256 in the range -32768 to +32512 (excluding 0).

The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<simm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".

This instruction is used by the aliases FMOV (zero, predicated), and MOV (immediate, predicated, merging).



SVE

```
CPY <Zd>.<T>, <Pg>/M, #<ZM>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer d = UInt(Zd);
boolean merging = TRUE;
boolean merging = (M == '1');
integer imm = SInt(imm8);
if sh == '1' then imm = imm << 8;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<imm> Is a signed immediate in the range -128 to 127, encoded in the "imm8" field.

<ZM> Is the predication qualifier, encoded in “M”:

M	<ZM>
0	Z
1	M

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

<imm> Is a signed immediate in the range -128 to 127, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) dest = Z[d];
bits(VL) result;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = imm<esize-1:0>;
    elsif merging then
        Elem[result, e, esize] = Elem[dest, e, esize];
    else
        Elem[result, e, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

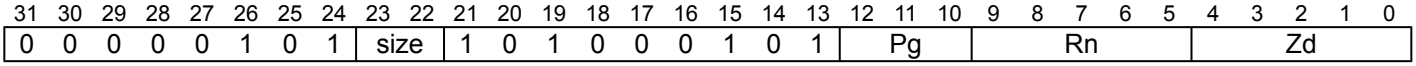
(old) htmldiff from- (new)

CPY (scalar)

Copy general-purpose register to vector elements (predicated).

Copy the general-purpose scalar source register to each active element in the destination vector. Inactive elements in the destination vector register remain unmodified.

This instruction is used by the alias MOV (scalar, predicated).



SVE

```
CPY <Zd>.<T>, <Pg>/M, <R><n|SP>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Rn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<n|SP> Is the number [0-30] of the general-purpose source register or the name SP (31), encoded in the "Rn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(64) operand1;
if n == 31 then
    operand1 = SP[];
else
    operand1 = X[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = operand1<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

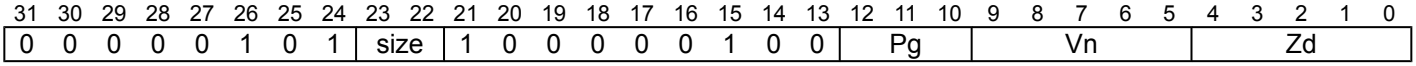
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

CPY (SIMD&FP scalar)

Copy SIMD&FP scalar register to vector elements (predicated).

Copy the SIMD & floating-point scalar source register to each active element in the destination vector. Inactive elements in the destination vector register remain unmodified.

This instruction is used by the alias MOV (SIMD&FP scalar, predicated).



SVE

```
CPY <Zd>.<T>, <Pg>/M, <V><n>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Vn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<n> Is the number [0-31] of the source SIMD&FP register, encoded in the "Vn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(esize) operand1 = V[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = operand1;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

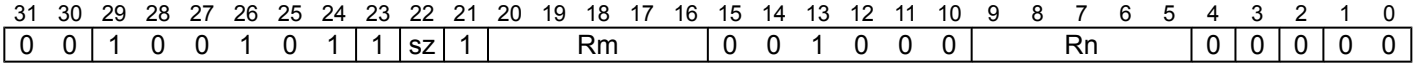
CTERMEQ, CTERMNE

Compare and terminate loop.

Detect termination conditions in serialized vector loops. Tests whether the comparison between the scalar source operands holds true and if not tests the state of the !LAST condition flag (C) which indicates whether the previous flag-setting predicate instruction selected the last element of the vector partition.
The Z and C condition flags are preserved by this instruction. The N and V condition flags are set as a pair to generate one of the following conditions for a subsequent conditional instruction:
* GE (N=0 & V=0): continue loop (compare failed and last element not selected);
* LT (N=0 & V=1): terminate loop (last element selected);
* LT (N=1 & V=0): terminate loop (compare succeeded);
The scalar source operands are 32-bit or 64-bit general-purpose registers of the same size.

It has encodings from 2 classes: Equal and Not equal

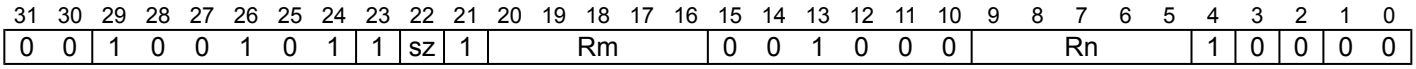
Equal



Equal

```
CTERMEQ <R><n>, <R><m>

if !HaveSVE() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Rn);
integer m = UInt(Rm);
SVECmp op = Cmp_EQ;
```

Not equal



Not equal

```
CTERMNE <R><n>, <R><m>

if !HaveSVE() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Rn);
integer m = UInt(Rm);
SVECmp op = Cmp_NE;
```

Assembler Symbols

<R> Is a width specifier, encoded in “sz”:

sz	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
bits(esize) operand1 = X[n];
bits(esize) operand2 = X[m];
integer element1 = UInt(operand1);
integer element2 = UInt(operand2);
boolean term;

case op of
    when Cmp_EQ term = element1 == element2;
    when Cmp_NE term = element1 != element2;
if term then
    PSTATE.N = '1';
    PSTATE.V = '0';
else
    PSTATE.N = '0';
    PSTATE.V = (NOT PSTATE.C);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

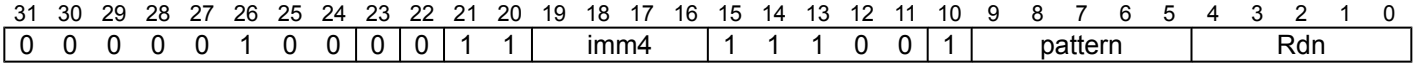
DECB, DECD, DECH, DECW (scalar)

Decrement scalar by multiple of predicate constraint element count.

Determines the number of active elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 4 classes: Byte , Doubleword , Halfword and Word

Byte

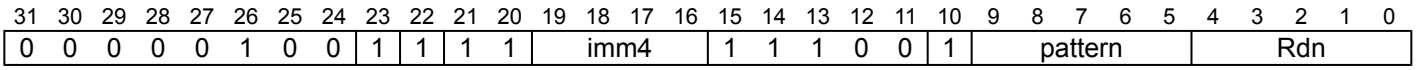


Byte

```
DECB <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Doubleword

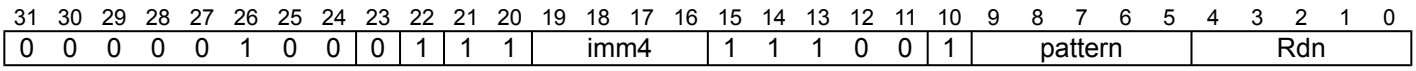


Doubleword

```
DECD <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Halfword

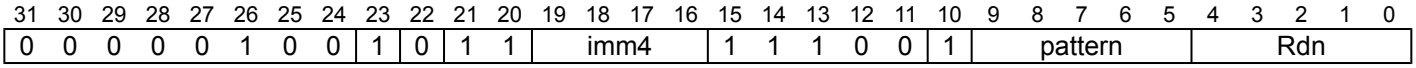


Halfword

```
DECH <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Word



Word

```
DECW <Xdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(64) operand1 = X[dn];

X[dn] = operand1 - (count * imm);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

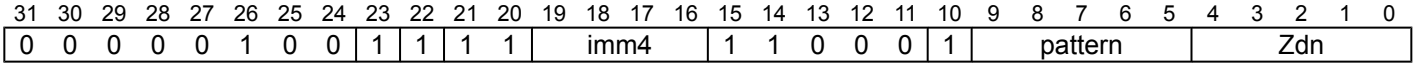
DECD, DECH, DECW (vector)

Decrement vector by multiple of predicate constraint element count.

Determines the number of active elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 3 classes: Doubleword , Halfword and Word

Doubleword

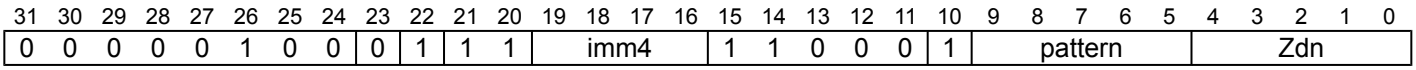


Doubleword

```
DECD <Zdn>.D{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Halfword

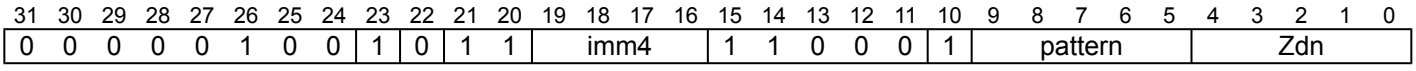


Halfword

```
DECH <Zdn>.H{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Word



Word

```
DECW <Zdn>.S{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    Elem[result, e, esize] = Elem[operand1, e, esize] - (count * imm);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

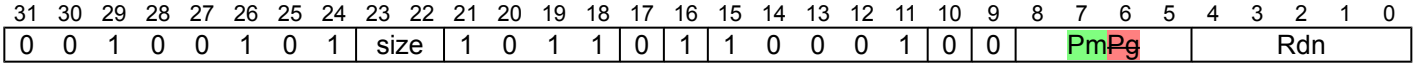
- An unpredicated MOVPRFX instruction.

(old) htmldiff from- (new)

DECP (scalar)

Decrement scalar by countactive ofpredicate trueelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to decrement the scalar destination.



SVE

```
DECP <Xdn>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(64) operand1 =bits(PL) mask = P[g];
bits(64) operand = X[dn];
bits(PL) operand2 = P[m];
[dn];
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

X[dn] = operand1 - count;[dn] = operand - count;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

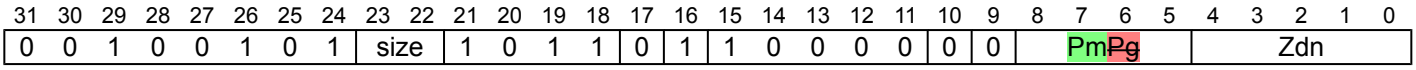
(old) htmldiff from- (new)

(old) htmldiff from- (new)

DECP (vector)

Decrement vector by countactive ofpredicate trueelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to decrement all destination vector elements.
The predicate size specifier may be omitted in assembler source code, but this is deprecated and will be prohibited in a future release of the architecture.



SVE

```
DECP <Zdn>.<T>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 =bits(PL) mask = P[g];
bits(VL) operand = Z[dn];
bits(PL) operand2 = P[m];
[dn];
bits(VL) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

for e = 0 to elements-1
    Elem[result, e, esize] = Elem[operand1, e, esize] - count;[operand, e, esize] - count;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

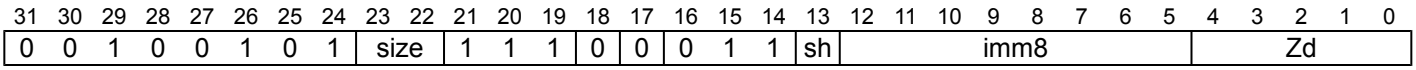
(old) htmldiff from- (new)

DUP (immediate)

Broadcast signed immediate to vector elements (unpredicated).

Unconditionally broadcast the signed integer immediate into each element of the destination vector. This instruction is unpredicated.
The immediate operand is a signed value in the range -128 to +127, and for element widths of 16 bits or higher it may also be a signed multiple of 256 in the range -32768 to +32512 (excluding 0).
The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<simm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".

This instruction is used by the aliases FMOV (zero, unpredicated), and MOV (immediate, unpredicated).



SVE

```
DUP <Zd>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer d = UInt(Zd);
integer imm = SInt(imm8);
if sh == '1' then imm = imm << 8;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is a signed immediate in the range -128 to 127, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
bits(VL) result = Replicate(imm<esize-1:0>);
Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

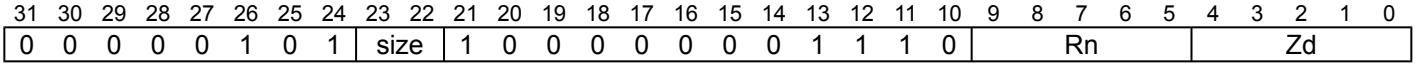
(old) htmldiff from- (new)

DUP (scalar)

Broadcast general-purpose register to vector elements (unpredicated).

Unconditionally broadcast the general-purpose scalar source register into each element of the destination vector. This instruction is unpredicated.

This instruction is used by the alias MOV (scalar, unpredicated).



SVE

```
DUP <Zd>.<T>, <R><n|SP>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Rn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<n|SP> Is the number [0-30] of the general-purpose source register or the name SP (31), encoded in the "Rn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(64) operand;
if n == 31 then
    operand = SP[];
else
    operand = X[n];
bits(VL) result;

for e = 0 to elements-1
    Elem[result, e, esize] = operand<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

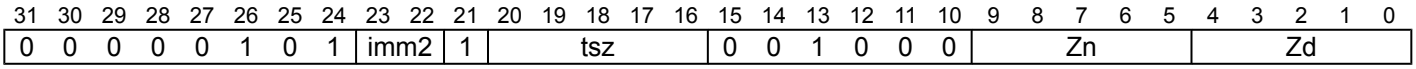
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

DUP (indexed)

Broadcast indexed element to vector (unpredicated).

Unconditionally broadcast the indexed source vector element into each element of the destination vector. This instruction is unpredicated.
The immediate element index is in the range of 0 to 63 (bytes), 31 (halfwords), 15 (words), 7 (doublewords) or 3 (quadwords). Selecting an element beyond the accessible vector length causes the destination vector to be set to zero.

This instruction is used by the alias MOV (SIMD&FP scalar, unpredicated).



SVE

```
DUP <Zd>.<T>, <Zn>.<T>[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
bits(7) imm = imm2:tsz;
case tsz of
    when '00000' UNDEFINED;
    when '10000' esize = 128; index = UInt(imm<6:5>);
    when 'x1000' esize = 64;  index = UInt(imm<6:4>);
    when 'xx100' esize = 32;  index = UInt(imm<6:3>);
    when 'xxx10' esize = 16;  index = UInt(imm<6:2>);
    when 'xxxx1' esize = 8;   index = UInt(imm<6:1>);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tsz”:

tsz	<T>
00000	RESERVED
xxxx1	B
xxx10	H
xx100	S
x1000	D
10000	Q

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<imm> Is the immediate index, in the range 0 to one less than the number of elements in 512 bits, encoded in "imm2:tsz".

Alias Conditions

Alias	Is preferred when
MOV (SIMD&FP scalar, unpredicated)	`BitCount(imm2:tsz) == 1`
MOV (SIMD&FP scalar, unpredicated)	`BitCount(imm2:tsz) > 1`

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;
bits(esize) element;

if index >= elements then
    element = Zeros();
else
    element = Elem[operand1, index, esize];
result = Replicate(element);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

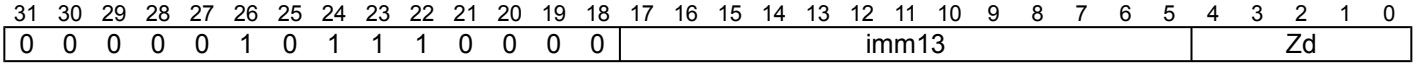
(old) htmldiff from- (new)

DUPM

Broadcast logical bitmask immediate to vector (unpredicated).

Unconditionally broadcast the logical bitmask immediate into each element of the destination vector. This instruction is unpredicated. The immediate is a 64-bit value consisting of a single run of ones or zeros repeating every 2, 4, 8, 16, 32 or 64 bits.

This instruction is used by the alias MOV (bitmask immediate).



SVE

```
DUPM <Zd>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer d = UInt(Zd);
bits(esize) imm;
(imm, -) = DecodeBitMasks(imm13<12>, imm13<5:0>, imm13<11:6>, TRUE);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “imm13<12>:imm13<5:0>”:

imm13<12>	imm13<5:0>	<T>
0	0xxxxx	S
0	10xxxx	H
0	110xxx	B
0	1110xx	B
0	11110x	B
0	111110	RESERVED
0	111111	RESERVED
1	xxxxxx	D

<const> Is a 64, 32, 16 or 8-bit bitmask consisting of replicated 2, 4, 8, 16, 32 or 64 bit fields, each field containing a rotated run of non-zero bits, encoded in the "imm13" field.

Alias Conditions

Alias	Is preferred when
MOV (bitmask immediate)	SVEMoveMaskPreferred(imm13)

Operation

```
CheckSVEEnabled();
bits(VL) result = Replicate(imm);
Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

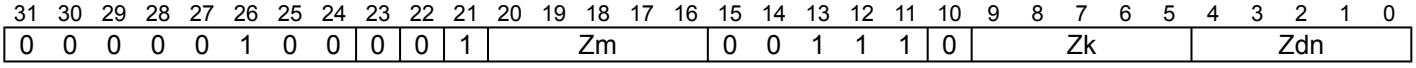
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

EOR3

Bitwise exclusive OR of three vectors.

Bitwise exclusive OR the corresponding elements of all three source vectors, and destructively place the results in the corresponding elements of the destination and first source vector. This instruction is unpredicated.



SVE2

```
EOR3 <Zdn>.D, <Zdn>.D, <Zm>.D, <Zk>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer m = UInt(Zm);
integer k = UInt(Zk);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<Zk>	Is the name of the third source scalable vector register, encoded in the "Zk" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[k];

Z[dn] = operand1 EOR operand2 EOR operand3;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

EOR, EORS (predicates)

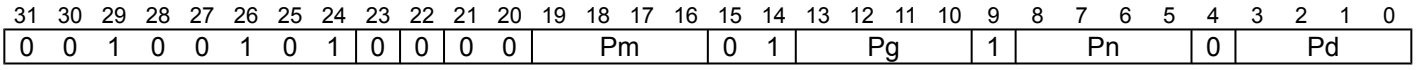
Bitwise exclusive OR predicates.

Bitwise exclusive OR active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

This instruction is used by the aliases NOTS, and NOT (predicate).

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

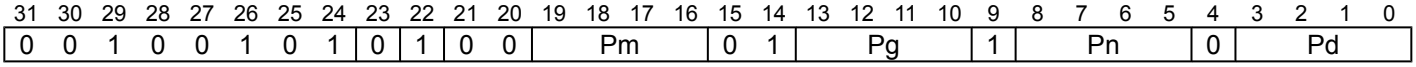


Not setting the condition flags

```
EOR <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
EORS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Alias Conditions

Alias	Is preferred when
NOTS	`Pm == Pg`

Alias	Is preferred when
NOT (predicate)	`Pm == Pg`

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = element1 EOR element2;
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

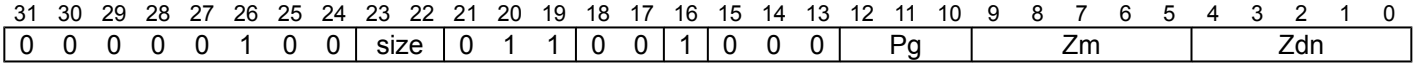
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

EOR (vectors, predicated)

Bitwise exclusive OR vectors (predicated).

Bitwise exclusive OR active elements of the second source vector with corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
EOR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1 EOR element2;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

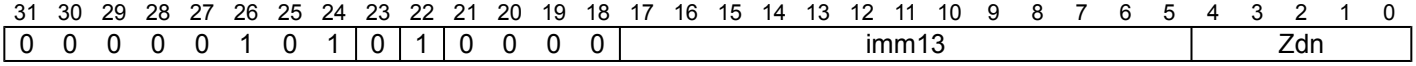
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

EOR (immediate)

Bitwise exclusive OR with immediate (unpredicated).

Bitwise exclusive OR an immediate with each 64-bit element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is a 64-bit value consisting of a single run of ones or zeros repeating every 2, 4, 8, 16, 32 or 64 bits. This instruction is unpredicated.

This instruction is used by the pseudo-instruction EON.



SVE

```
EOR <Zdn>.<T>, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
integer dn = UInt(Zdn);
bits(64) imm;
(imm, -) = DecodeBitMasks(imm13<12>, imm13<5:0>, imm13<11:6>, TRUE);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “imm13<12>:imm13<5:0>”:

imm13<12>	imm13<5:0>	<T>
0	0xxxxx	S
0	10xxxx	H
0	110xxx	B
0	1110xx	B
0	11110x	B
0	111110	RESERVED
0	111111	RESERVED
1	xxxxxx	D

<const> Is a 64, 32, 16 or 8-bit bitmask consisting of replicated 2, 4, 8, 16, 32 or 64 bit fields, each field containing a rotated run of non-zero bits, encoded in the "imm13" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV 64;
bits(VL) operand = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(64) element1 = Elem[operand, e, 64];
    Elem[result, e, 64] = element1 EOR imm;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

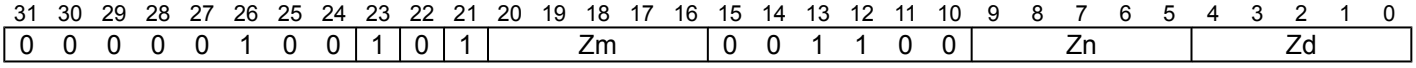
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

EOR (vectors, unpredicated)

Bitwise exclusive OR vectors (unpredicated).

Bitwise exclusive OR all elements of the second source vector with corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE

```
EOR <Zd>.D, <Zn>.D, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];

Z[d] = operand1 EOR operand2;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

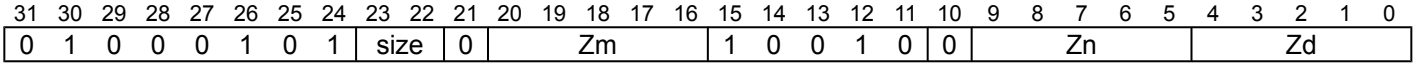
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

EORBT

Interleaving exclusive OR (bottom, top).

Interleaving exclusive OR between the even-numbered elements of the first source vector register and the odd-numbered elements of the second source vector register, placing the result in the even-numbered elements of the destination vector, leaving the odd-numbered elements unchanged. This instruction is unpredicated.



SVE2

```
EORBT <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 1;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, 2*e + sel1, esize];
    bits(esize) element2 = Elem[operand2, 2*e + sel2, esize];
    Elem[result, 2*e + sel1, esize] = element1 EOR element2;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

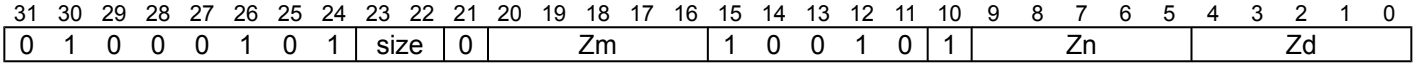
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

EORTB

Interleaving exclusive OR (top, bottom).

Interleaving exclusive OR between the odd-numbered elements of the first source vector register and the even-numbered elements of the second source vector register, placing the result in the odd-numbered elements of the destination vector, leaving the even-numbered elements unchanged. This instruction is unpredicated.



SVE2

```
EORTB <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 1;
integer sel2 = 0;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, 2*e + sel1, esize];
    bits(esize) element2 = Elem[operand2, 2*e + sel2, esize];
    Elem[result, 2*e + sel1, esize] = element1 EOR element2;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

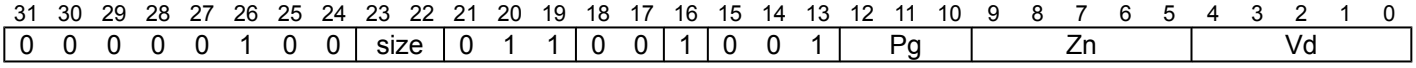
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

EORV

Bitwise exclusive OR reduction to scalar.

Bitwise exclusive OR horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as zero.



SVE

```
EORV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(esize) result = Zeros(esize);

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        result = result EOR Elem[operand, e, esize];

V[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

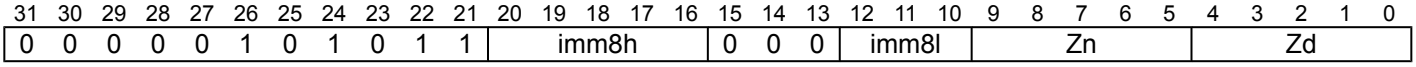
EXT

Extract vector from pair of vectors.

Copy the indexed byte up to the last byte of the first source vector to the bottom of the result vector, then fill the remainder of the result starting from the first byte of the second source vector. The result is placed destructively in the destination and first source vector, or constructively in the destination vector. This instruction is unpredicated.
An index that is greater than or equal to the vector length in bytes is treated as zero, resulting in the first source vector being copied to the result unchanged.

It has encodings from 2 classes: Constructive and Destructive

Constructive

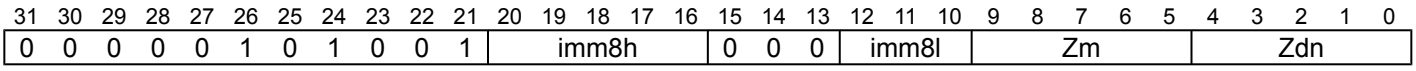


Constructive

```
EXT <Zd>.B, { <Zn1>.B, <Zn2>.B }, #<imm>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8;
integer dst = UInt(Zd);
integer s1 = UInt(Zn);
integer s2 = (s1 + 1) MOD 32;
integer position = UInt(imm8h:imm8l);
```

Destructive



Destructive

```
EXT <Zdn>.B, <Zdn>.B, <Zm>.B, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dst = UInt(Zdn);
integer s1 = dst;
integer s2 = UInt(Zm);
integer position = UInt(imm8h:imm8l);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn1>	Is the name of the first scalable vector register of a multi-vector sequence, encoded in the "Zn" field.
<Zn2>	Is the name of the second scalable vector register of a multi-vector sequence, encoded in the "Zn" field.
<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<imm>	Is the unsigned immediate operand, in the range 0 to 255, encoded in the "imm8h:imm8l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[s1];
bits(VL) operand2 = Z[s2];
bits(VL) result;

if position >= elements then
    position = 0;

position = position << 3;
bits(VL*2) concat = operand2 : operand1;
result = concat<position+VL-1:position>;

Z[dst] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

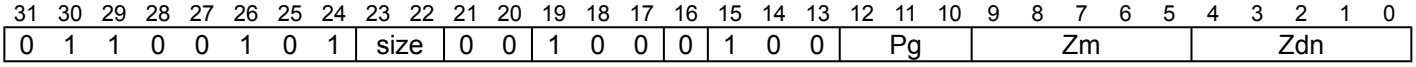
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FABD

Floating-point absolute difference (predicated).

Compute the absolute difference of active floating-point elements of the second source vector and corresponding floating-point elements of the first source vector and destructively place the result in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FABD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPAbs(FPSub(element1, element2, FPCR));
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

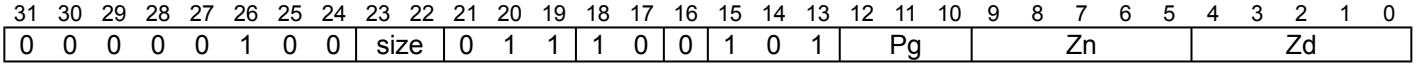
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

FABS

Floating-point absolute value (predicated).

Take the absolute value of each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. This clears the sign bit and cannot signal a floating-point exception. Inactive elements in the destination vector register remain unmodified.



SVE

```
FABS <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPAbs(element);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

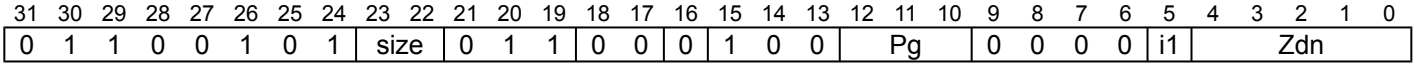
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FADD (immediate)

Floating-point add immediate (predicated).

Add an immediate to each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.5 or +1.0 only. Inactive elements in the destination vector register remain unmodified.



SVE

```
FADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then FPPointFive('0') else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.5
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPAdd(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

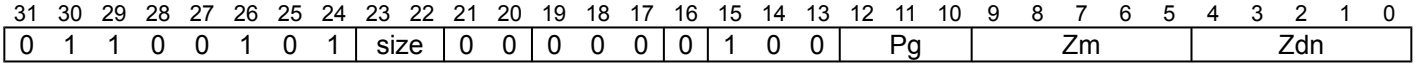
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FADD (vectors, predicated)

Floating-point add vector (predicated).

Add active floating-point elements of the second source vector to corresponding floating-point elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPAdd(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

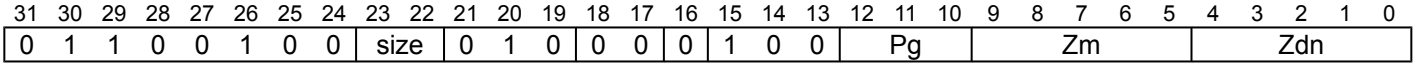
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

FADDP

Floating-point add pairwise.

Add pairs of adjacent floating-point elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
FADDP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[dn];
bits(esize) element1;
bits(esize) element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        if IsEven(e) then
            element1 = Elem[operand1, e + 0, esize];
            element2 = Elem[operand1, e + 1, esize];
        else
            element1 = Elem[operand2, e - 1, esize];
            element2 = Elem[operand2, e + 0, esize];
        Elem[result, e, esize] = FPAdd(element1, element2, FPCR);

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

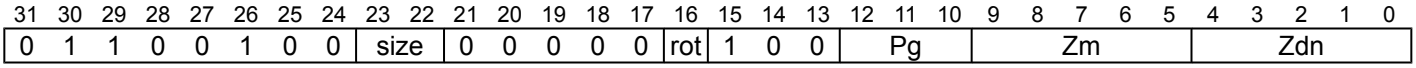
(old) htmldiff from- (new)

FCADD

Floating-point complex add with rotate (predicated).

Add the real and imaginary components of the active floating-point complex numbers from the first source vector to the complex numbers from the second source vector which have first been rotated by 90 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation, equivalent to multiplying the complex numbers in the second source vector by ±J beforehand. Destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.



SVE

```
FCADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean sub_i = (rot == '0');
boolean sub_r = (rot == '1');
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
0	#90
1	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for p = 0 to pairs-1
    acc_r  = Elem[operand1, 2 * p + 0, esize];
    acc_i  = Elem[operand1, 2 * p + 1, esize];
    elt2_r = Elem[operand2, 2 * p + 0, esize];
    elt2_i = Elem[operand2, 2 * p + 1, esize];
    if ElemP[mask, 2 * p + 0, esize] == '1' then
        if sub_i then elt2_i = FPNeg(elt2_i);
        acc_r = FPAdd(acc_r, elt2_i, FPCR);
    if ElemP[mask, 2 * p + 1, esize] == '1' then
        if sub_r then elt2_r = FPNeg(elt2_r);
        acc_i = FPAdd(acc_i, elt2_r, FPCR);
    Elem[result, 2 * p + 0, esize] = acc_r;
    Elem[result, 2 * p + 1, esize] = acc_i;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FCMLA (vectors)

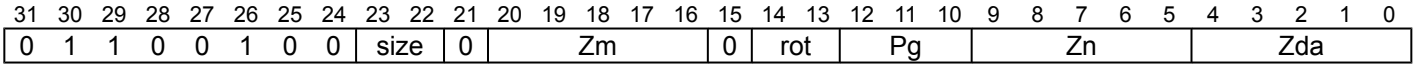
Floating-point complex multiply-add with rotate (predicated).

Multiply the duplicated real components for rotations 0 and 180, or imaginary components for rotations 90 and 270, of the floating-point complex numbers in the first source vector by the corresponding complex number in the second source vector rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation.

Then destructively add the products to the corresponding components of the complex numbers in the addend and destination vector, without intermediate rounding.

These transformations permit the creation of a variety of multiply-add and multiply-subtract operations on complex numbers by combining two of these instructions with the same vector operands but with rotations that are 90 degrees apart.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element. Inactive elements in the destination vector register remain unmodified.



SVE

```
FCMLA <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean neg_i = (rot<1> == '1');
boolean neg_r = (rot<0> != rot<1>);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for p = 0 to pairs-1
    addend_r = Elem[operand3, 2 * p + 0, esize];
    addend_i = Elem[operand3, 2 * p + 1, esize];
    elt1_a   = Elem[operand1, 2 * p + sel_a, esize];
    elt2_a   = Elem[operand2, 2 * p + sel_a, esize];
    elt2_b   = Elem[operand2, 2 * p + sel_b, esize];
    if ElemP[mask, 2 * p + 0, esize] == '1' then
        if neg_r then elt2_a = FPNeg(elt2_a);
        addend_r = FPMulAdd(addend_r, elt1_a, elt2_a, FPCR);
    if ElemP[mask, 2 * p + 1, esize] == '1' then
        if neg_i then elt2_b = FPNeg(elt2_b);
        addend_i = FPMulAdd(addend_i, elt1_a, elt2_b, FPCR);
    Elem[result, 2 * p + 0, esize] = addend_r;
    Elem[result, 2 * p + 1, esize] = addend_i;

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FCMLA (indexed)

Floating-point complex multiply-add by indexed values with rotate.

Multiply the duplicated real components for rotations 0 and 180, or imaginary components for rotations 90 and 270, of the floating-point complex numbers in each 128-bit segment of the first source vector by the specified complex number in the corresponding the second source vector segment rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation.

Then destructively add the products to the corresponding components of the complex numbers in the addend and destination vector, without intermediate rounding.

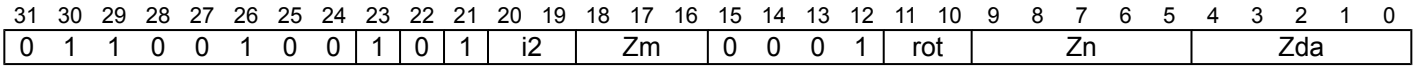
These transformations permit the creation of a variety of multiply-add and multiply-subtract operations on complex numbers by combining two of these instructions with the same vector operands but with rotations that are 90 degrees apart.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.

The complex numbers within the second source vector are specified using an immediate index which selects the same complex number position within each 128-bit vector segment. The index range is from 0 to one less than the number of complex numbers per 128-bit segment, encoded in 1 to 2 bits depending on the size of the complex number. This instruction is unpredicated.

It has encodings from 2 classes: Half-precision and Single-precision

Half-precision

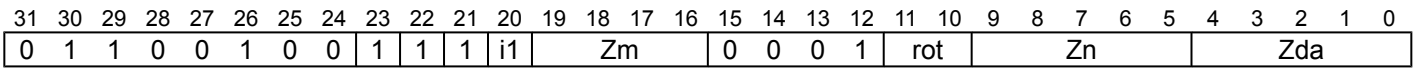


Half-precision

```
FCMLA <Zda>.H, <Zn>.H, <Zm>.H[<imm>], <const>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean neg_i = (rot<1> == '1');
boolean neg_r = (rot<0> != rot<1>);
```

Single-precision



Single-precision

```
FCMLA <Zda>.S, <Zn>.S, <Zm>.S[<imm>], <const>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean neg_i = (rot<1> == '1');
boolean neg_r = (rot<0> != rot<1>);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> For the half-precision variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.

For the single-precision variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.

<imm> For the half-precision variant: is the index of a Real and Imaginary pair, in the range 0 to 3, encoded in the "i2" field.

For the single-precision variant: is the index of a Real and Imaginary pair, in the range 0 to 1, encoded in the "i1" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
integer pairspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for p = 0 to pairs-1
    segmentbase = p - p MOD pairspersegment;
    s = segmentbase + index;
    addend_r = Elem[operand3, 2 * p + 0, esize];
    addend_i = Elem[operand3, 2 * p + 1, esize];
    elt1_a   = Elem[operand1, 2 * p + sel_a, esize];
    elt2_a   = Elem[operand2, 2 * s + sel_a, esize];
    elt2_b   = Elem[operand2, 2 * s + sel_b, esize];
    if neg_r then elt2_a = FPNeg(elt2_a);
    if neg_i then elt2_b = FPNeg(elt2_b);
    addend_r = FPMulAdd(addend_r, elt1_a, elt2_a, FPCR);
    addend_i = FPMulAdd(addend_i, elt1_a, elt2_b, FPCR);
    Elem[result, 2 * p + 0, esize] = addend_r;
    Elem[result, 2 * p + 1, esize] = addend_i;

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

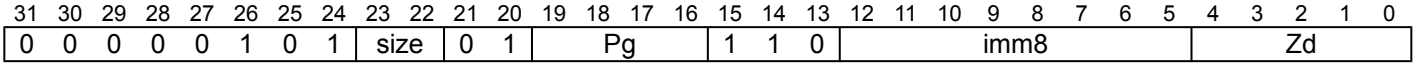
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

FCPY

Copy 8-bit floating-point immediate to vector elements (predicated).

Copy a floating-point immediate into each active element in the destination vector. Inactive elements in the destination vector register remain unmodified.

This instruction is used by the alias FMOV (immediate, predicated).



SVE

```
FCPY <Zd>.<T>, <Pg>/M, #<const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer d = UInt(Zd);
bits(esize) imm = VFPExpandImm(imm8);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<const> Is a floating-point immediate value expressable as ±n÷16×2^r, where n and r are integers such that 16 ≤ n ≤ 31 and -3 ≤ r ≤ 4, i.e. a normalized binary floating-point encoding with 1 sign bit, 3-bit exponent, and 4-bit fractional part, encoded in the "imm8" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) result = Z[d];

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = imm;

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

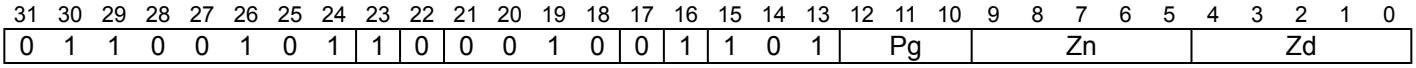
FCVT

Floating-point convert precision (predicated).

Convert the size and precision of each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
Since the input and result types have a different size the smaller type is held unpacked in the least significant bits of elements of the larger size. When the input is the smaller type the upper bits of each source element are ignored. When the result is the smaller type the upper bits of each destination element are set to zero.

It has encodings from 6 classes: Half-precision to single-precision , Half-precision to double-precision , Single-precision to half-precision , Single-precision to double-precision , Double-precision to half-precision and Double-precision to single-precision

Half-precision to single-precision

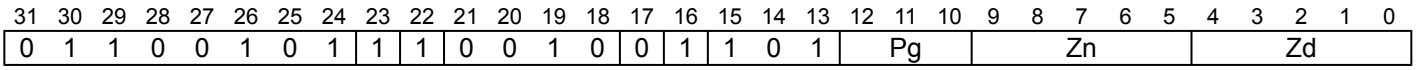


Half-precision to single-precision

```
FCVT <Zd>.S, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 32;
```

Half-precision to double-precision

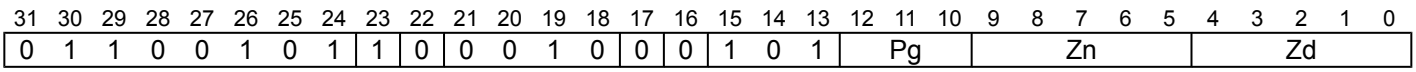


Half-precision to double-precision

```
FCVT <Zd>.D, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 64;
```

Single-precision to half-precision

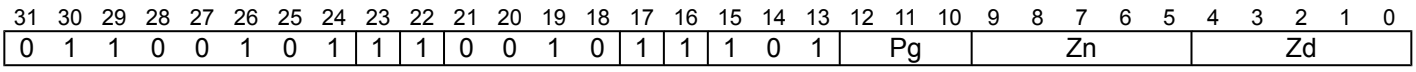


Single-precision to half-precision

```
FCVT <Zd>.H, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 16;
```

Single-precision to double-precision

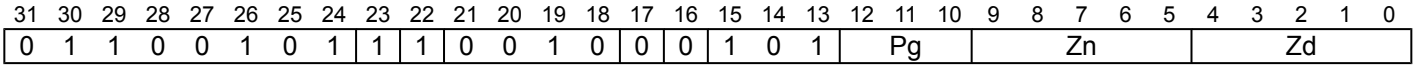


Single-precision to double-precision

```
FCVT <Zd>.D, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 64;
```

Double-precision to half-precision

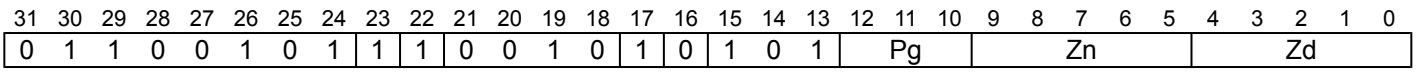


Double-precision to half-precision

```
FCVT <Zd>.H, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 16;
```

Double-precision to single-precision



Double-precision to single-precision

```
FCVT <Zd>.S, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 32;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        bits(d_esize) res = FPConvertSVE(element<s_esize-1:0>, FPCR);
        Elem[result, e, esize] = ZeroExtend(res);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

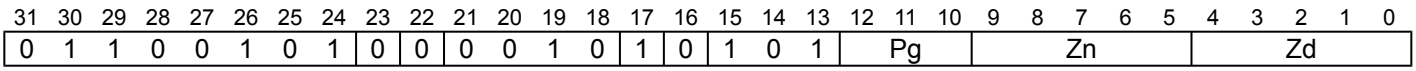
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FCVTX

Floating-point down convert, rounding to odd (predicated).

Convert active double-precision floating-point elements from the source vector to single-precision, rounding to Odd, and place the results in the even-numbered 32-bit elements of the destination vector, while setting the odd-numbered elements to zero. Inactive elements in the destination vector register remain unmodified.
Rounding to Odd (aka Von Neumann rounding) permits a two-step conversion from double-precision to half-precision without incurring intermediate rounding errors.



Double-precision to single-precision

```
FCVTX <Zd>.S, <Pg>/M, <Zn>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 32;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        bits(d_esize) res = FPConvertSVE(element<s_esize-1:0>, FPCR, FPRounding_ODD);
        Elem[result, e, esize] = ZeroExtend(res);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

(old) htmldiff from- (new)

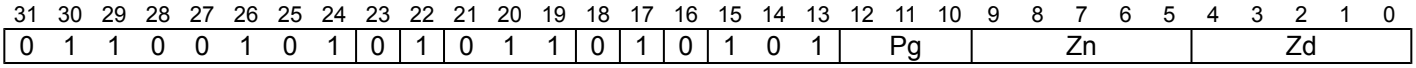
FCVTZS

Floating-point convert to signed integer, rounding toward zero (predicated).

Convert to the signed integer nearer to zero from each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
If the input and result types have a different size the smaller type is held unpacked in the least significant bits of elements of the larger size. When the input is the smaller type the upper bits of each source element are ignored. When the result is the smaller type the upper bits of each destination element are set to zero.

It has encodings from 7 classes: Half-precision to 16-bit , Half-precision to 32-bit , Half-precision to 64-bit , Single-precision to 32-bit , Single-precision to 64-bit , Double-precision to 32-bit and Double-precision to 64-bit

Half-precision to 16-bit

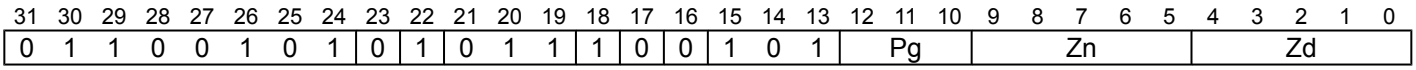


Half-precision to 16-bit

```
FCVTZS <Zd>.H, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 16;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Half-precision to 32-bit

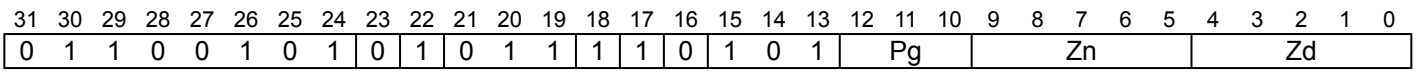


Half-precision to 32-bit

```
FCVTZS <Zd>.S, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 32;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Half-precision to 64-bit

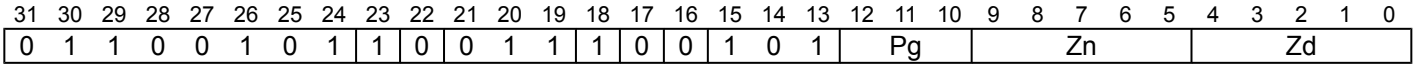


Half-precision to 64-bit

```
FCVTZS <Zd>.D, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 64;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Single-precision to 32-bit

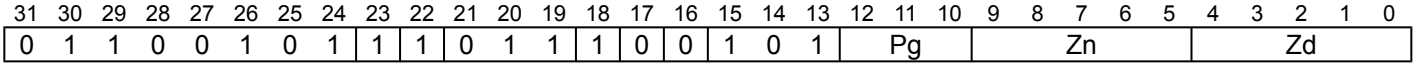


Single-precision to 32-bit

```
FCVTZS <Zd>.S, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 32;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Single-precision to 64-bit

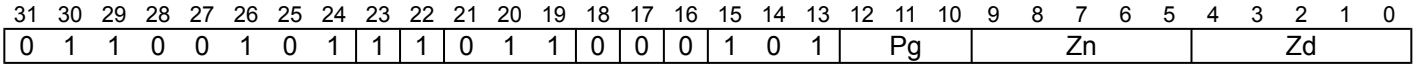


Single-precision to 64-bit

```
FCVTZS <Zd>.D, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 64;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Double-precision to 32-bit

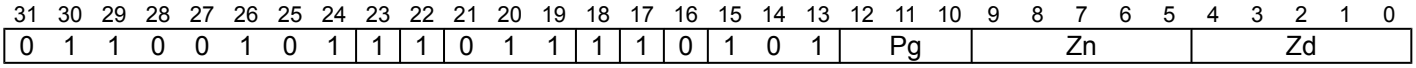


Double-precision to 32-bit

```
FCVTZS <Zd>.S, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 32;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Double-precision to 64-bit



Double-precision to 64-bit

```
FCVTZS <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 64;
boolean unsigned = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        bits(d_esize) res = FPToFixed(element<s_esize-1:0>, 0, unsigned, FPCR, rounding);
        Elem[result, e, esize] = Extend(res, unsigned);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

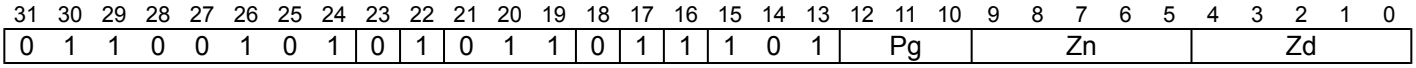
FCVTZU

Floating-point convert to unsigned integer, rounding toward zero (predicated).

Convert to the unsigned integer nearer to zero from each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
If the input and result types have a different size the smaller type is held unpacked in the least significant bits of elements of the larger size. When the input is the smaller type the upper bits of each source element are ignored. When the result is the smaller type the upper bits of each destination element are set to zero.

It has encodings from 7 classes: Half-precision to 16-bit , Half-precision to 32-bit , Half-precision to 64-bit , Single-precision to 32-bit , Single-precision to 64-bit , Double-precision to 32-bit and Double-precision to 64-bit

Half-precision to 16-bit

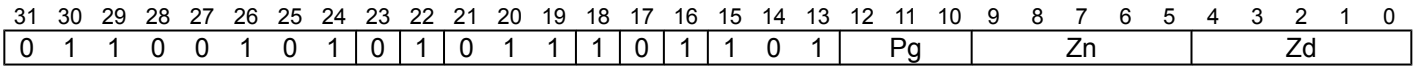


Half-precision to 16-bit

```
FCVTZU <Zd>.H, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 16;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Half-precision to 32-bit

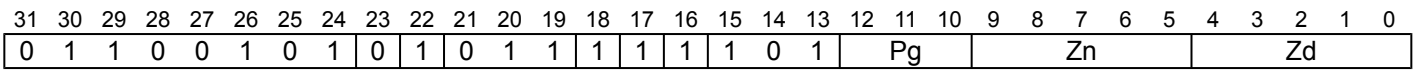


Half-precision to 32-bit

```
FCVTZU <Zd>.S, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 32;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Half-precision to 64-bit

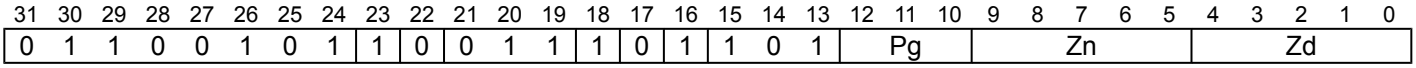


Half-precision to 64-bit

```
FCVTZU <Zd>.D, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 64;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Single-precision to 32-bit

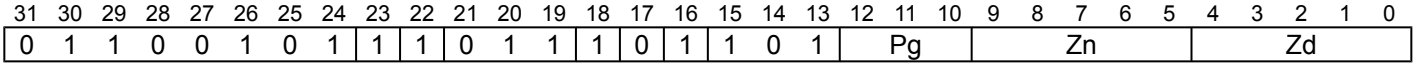


Single-precision to 32-bit

```
FCVTZU <Zd>.S, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 32;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Single-precision to 64-bit

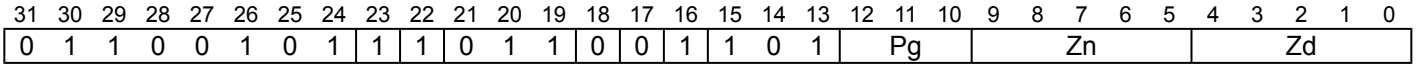


Single-precision to 64-bit

```
FCVTZU <Zd>.D, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 64;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Double-precision to 32-bit

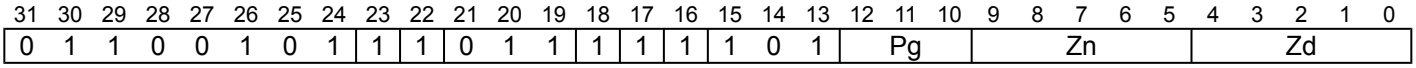


Double-precision to 32-bit

```
FCVTZU <Zd>.S, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 32;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Double-precision to 64-bit



Double-precision to 64-bit

```
FCVTZU <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 64;
boolean unsigned = TRUE;
FPRounding rounding = FPRounding_ZERO;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        bits(d_esize) res = FPToFixed(element<s_esize-1:0>, 0, unsigned, FPCR, rounding);
        Elem[result, e, esize] = Extend(res, unsigned);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

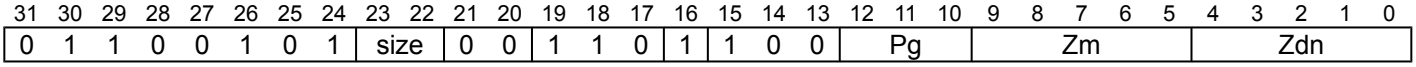
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FDIV

Floating-point divide by vector (predicated).

Divide active floating-point elements of the first source vector by corresponding floating-point elements of the second source vector and destructively place the quotient in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FDIV <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPDiv(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

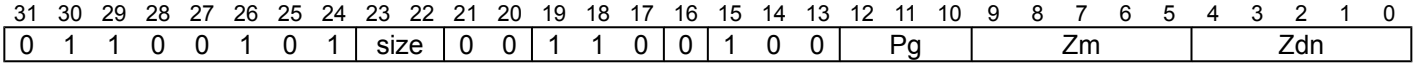
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

FDIVR

Floating-point reversed divide by vector (predicated).

Reversed divide active floating-point elements of the second source vector by corresponding floating-point elements of the first source vector and destructively place the quotient in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FDIVR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPDiv(element2, element1, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

FLOGB

Floating-point base 2 logarithm as integer.

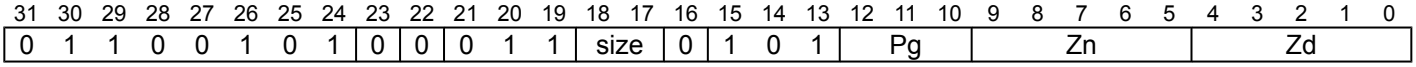
This instruction returns the signed integer base 2 logarithm of each floating-point input element |X| after normalization.

This is the unbiased exponent of X used in the representation of the floating-point value, such that, for positive X, X = significand × $2^{exponent}$.

The integer results are placed in elements of the destination vector which have the same width (ESIZE) as the floating-point input elements:

* If X is normal, the result is the base 2 logarithm of X.
* If X is subnormal, the result corresponds to the normalized representation.
* If X is infinite, the result is $2^{(esize-1)}$-1.
* If X is ±0.0 or NaN, the result is $-2^{(esize-1)}$.

Inactive elements in the destination vector register remain unmodified.



SVE2

```
FLOGB <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPLogB(element, FPCR);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

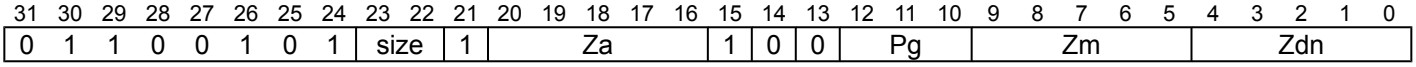
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMAD

Floating-point fused multiply-add vectors (predicated), writing multiplicand [Zdn = Za + Zdn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and add to elements of the third (addend) vector without intermediate rounding. Destructively place the results in the destination and first source (multiplicand) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMAD <Zdn>.<T>, <Pg>/M, <Zm>.<T>, <Za>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer a = UInt(Za);
boolean op1_neg = FALSE;
boolean op3_neg = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Za> Is the name of the third source scalable vector register, encoded in the "Za" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[a];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

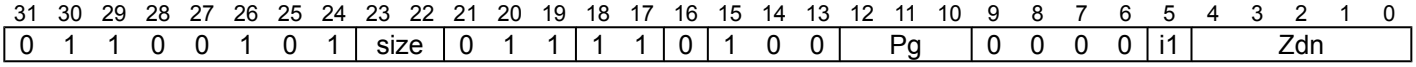
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMAX (immediate)

Floating-point maximum with immediate (predicated).

Determine the maximum of an immediate and each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.0 or +1.0 only. If the element value is NaN then the result is NaN. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMAX <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then Zeros() else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.0
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMax(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

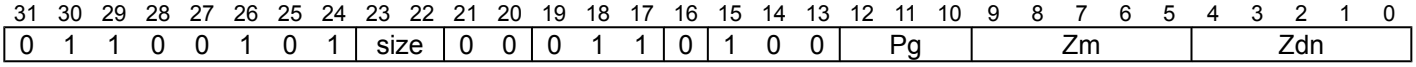
(old) htmldiff from- (new)

(old) htmldiff from- (new)

FMAX (vectors)

Floating-point maximum (predicated).

Determine the maximum of active floating-point elements of the second source vector and corresponding floating-point elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. If either element value is NaN then the result is NaN. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMAX <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMax(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

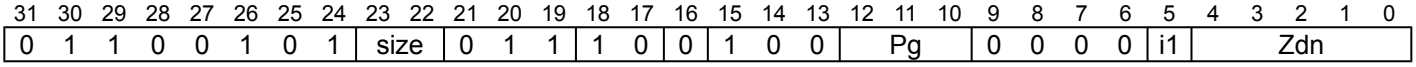
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMAXNM (immediate)

Floating-point maximum number with immediate (predicated).

Determine the maximum number value of an immediate and each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.0 or +1.0 only. If the element value is NaN then the result is the immediate. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMAXNM <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then Zeros() else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.0
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMaxNum(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

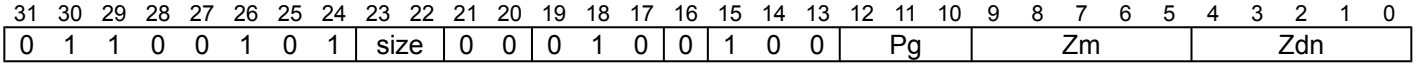
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMAXNM (vectors)

Floating-point maximum number (predicated).

Determine the maximum number value of active floating-point elements of the second source vector and corresponding floating-point elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. If one element value is NaN then the result is the numeric value. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMAXNM <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMaxNum(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

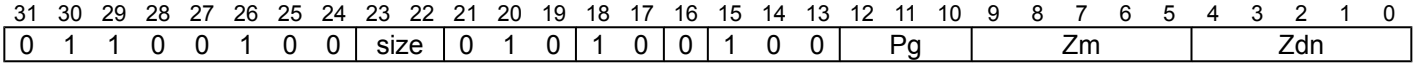
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

FMAXNMP

Floating-point maximum number pairwise.

Compute the maximum value of each pair of adjacent floating-point elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector. NaNs are handled according to the IEEE 754-2008 standard. If one vector element is numeric and the other is a quiet NaN, the result is the numerical value.



SVE2

```
FMAXNMP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[dn];
bits(esize) element1;
bits(esize) element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        if IsEven(e) then
            element1 = Elem[operand1, e + 0, esize];
            element2 = Elem[operand1, e + 1, esize];
        else
            element1 = Elem[operand2, e - 1, esize];
            element2 = Elem[operand2, e + 0, esize];
        Elem[result, e, esize] = FPMaxNum(element1, element2, FPCR);

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

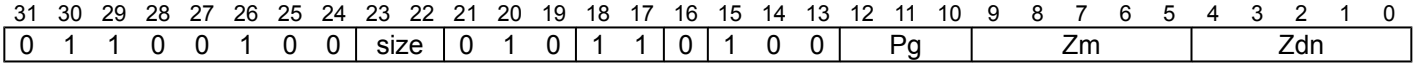
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMAXP

Floating-point maximum pairwise.

Compute the maximum value of each pair of adjacent floating-point elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
FMAXP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[dn];
bits(esize) element1;
bits(esize) element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        if IsEven(e) then
            element1 = Elem[operand1, e + 0, esize];
            element2 = Elem[operand1, e + 1, esize];
        else
            element1 = Elem[operand2, e - 1, esize];
            element2 = Elem[operand2, e + 0, esize];
        Elem[result, e, esize] = FPMax(element1, element2, FPCR);

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

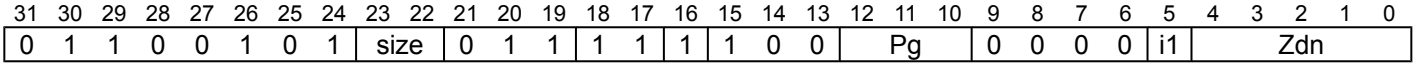
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMIN (immediate)

Floating-point minimum with immediate (predicated).

Determine the minimum of an immediate and each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.0 or +1.0 only. If the element value is NaN then the result is NaN. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMIN <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then Zeros() else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.0
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMin(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

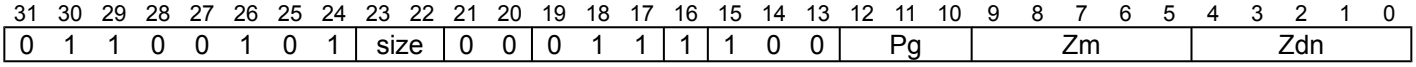
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMIN (vectors)

Floating-point minimum (predicated).

Determine the minimum of active floating-point elements of the second source vector and corresponding floating-point elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. If either element value is NaN then the result is NaN. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMIN <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMin(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

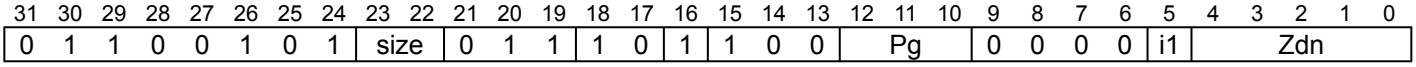
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMINNM (immediate)

Floating-point minimum number with immediate (predicated).

Determine the minimum number value of an immediate and each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.0 or +1.0 only. If the element value is NaN then the result is the immediate. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMINNM <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then Zeros() else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.0
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMinNum(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

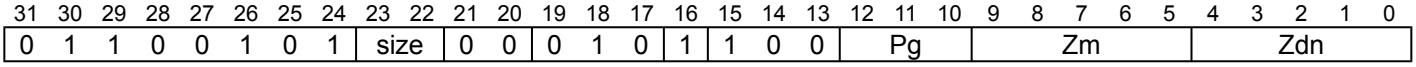
(old) htmldiff from- (new)

(old) htmldiff from- (new)

FMINNM (vectors)

Floating-point minimum number (predicated).

Determine the minimum number value of active floating-point elements of the second source vector and corresponding floating-point elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. If one element value is NaN then the result is the numeric value. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMINNM <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMinNum(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

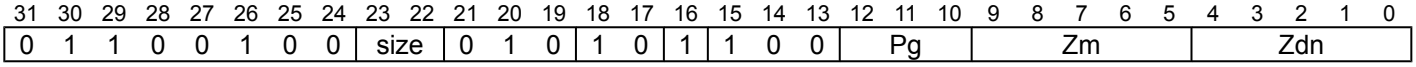
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

FMINNMP

Floating-point minimum number pairwise.

Compute the minimum value of each pair of adjacent floating-point elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector. NaNs are handled according to the IEEE 754-2008 standard. If one vector element is numeric and the other is a quiet NaN, the result is the numerical value.



SVE2

```
FMINNMP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[dn];
bits(esize) element1;
bits(esize) element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        if IsEven(e) then
            element1 = Elem[operand1, e + 0, esize];
            element2 = Elem[operand1, e + 1, esize];
        else
            element1 = Elem[operand2, e - 1, esize];
            element2 = Elem[operand2, e + 0, esize];
        Elem[result, e, esize] = FPMinNum(element1, element2, FPCR);

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

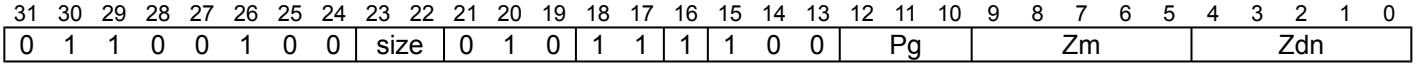
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMINP

Floating-point minimum pairwise.

Compute the minimum value of each pair of adjacent floating-point elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
FMINP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[dn];
bits(esize) element1;
bits(esize) element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        if IsEven(e) then
            element1 = Elem[operand1, e + 0, esize];
            element2 = Elem[operand1, e + 1, esize];
        else
            element1 = Elem[operand2, e - 1, esize];
            element2 = Elem[operand2, e + 0, esize];
        Elem[result, e, esize] = FPMin(element1, element2, FPCR);

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

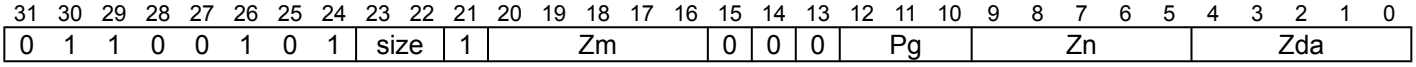
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

FMLA (vectors)

Floating-point fused multiply-add vectors (predicated), writing addend [Zda = Zda + Zn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and add to elements of the third source (addend) vector without intermediate rounding. Destructively place the results in the destination and third source (addend) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMLA <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
boolean op3_neg = FALSE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element3;

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

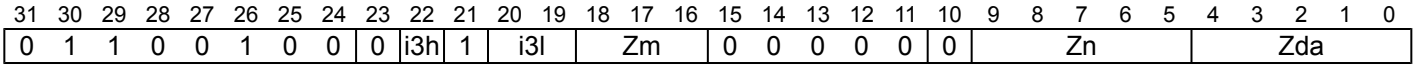
FMLA (indexed)

Floating-point fused multiply-add by indexed elements (Zda = Zda + Zn * Zm[indexed]).

Multiply all floating-point elements within each 128-bit segment of the first source vector by the specified element in the corresponding second source vector segment. The products are then destructively added without intermediate rounding to the corresponding elements of the addend and destination vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element. This instruction is unpredicated.

It has encodings from 3 classes: Half-precision , Single-precision and Double-precision

Half-precision

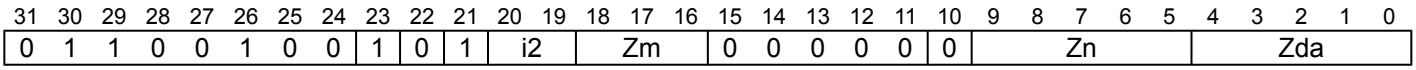


Half-precision

```
FMLA <Zda>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
boolean op3_neg = FALSE;
```

Single-precision

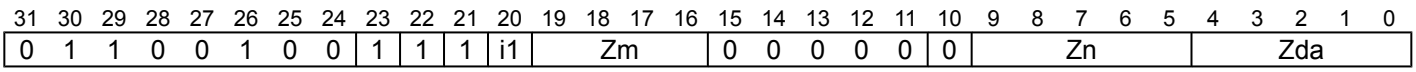


Single-precision

```
FMLA <Zda>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
boolean op3_neg = FALSE;
```

Double-precision



Double-precision

```
FMLA <Zda>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
boolean op3_neg = FALSE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the half-precision and single-precision variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the double-precision variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the half-precision variant: is the immediate index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the single-precision variant: is the immediate index, in the range 0 to 3, encoded in the "i2" field. For the double-precision variant: is the immediate index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, s, esize];
    bits(esize) element3 = Elem[result, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    if op3_neg then element3 = FPNeg(element3);
    Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

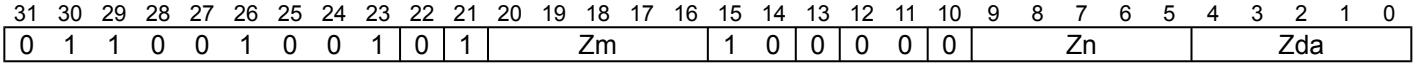
The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

FMLALB (vectors)

Half-precision floating-point multiply-add long to single-precision (bottom).

This half-precision floating-point multiply-add long instruction widens the even-numbered 16-bit half-precision elements in the first source vector and the corresponding elements in the second source vector to single-precision format and then destructively multiplies and adds these values without intermediate rounding to the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



SVE2

```
FMLALB <Zda>.S, <Zn>.H, <Zm>.H
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 0, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, 2 * e + 0, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

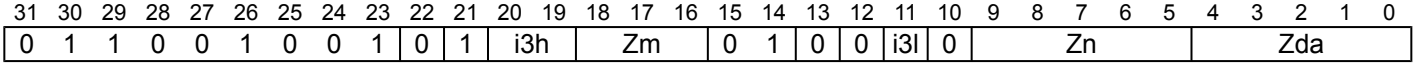
- An unpredicated MOVPRFX instruction.

(old) htmldiff from- (new)

FMLALB (indexed)

Half-precision floating-point multiply-add long to single-precision (bottom, indexed).

This half-precision floating-point multiply-add long instruction widens the even-numbered 16-bit half-precision elements in the first source vector and the indexed element from the corresponding 128-bit segment in the second source vector to single-precision format and then destructively multiplies and adds these values without intermediate rounding to the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



Single-precision

```
FMLALB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer index = UInt(i3h:i3l);
boolean op1_neg = FALSE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
<imm>	Is the immediate index, in the range 0 to 7, encoded in the "i3h:i3l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = 2 * segmentbase + index;
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 0, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, s, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

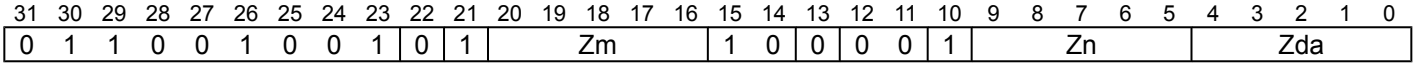
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

FMLALT (vectors)

Half-precision floating-point multiply-add long to single-precision (top).

This half-precision floating-point multiply-add long instruction widens the odd-numbered 16-bit half-precision elements in the first source vector and the corresponding elements in the second source vector to single-precision format and then destructively multiplies and adds these values without intermediate rounding to the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



SVE2

```
FMLALT <Zda>.S, <Zn>.H, <Zm>.H
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 1, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, 2 * e + 1, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

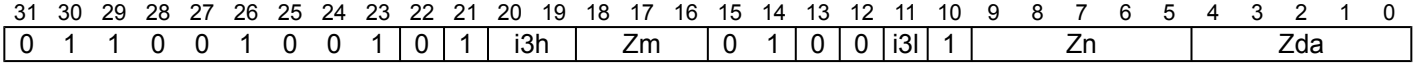
- An unpredicated MOVPRFX instruction.

(old) htmldiff from- (new)

FMLALT (indexed)

Half-precision floating-point multiply-add long to single-precision (top, indexed).

This half-precision floating-point multiply-add long instruction widens the odd-numbered 16-bit half-precision elements in the first source vector and the indexed element from the corresponding 128-bit segment in the second source vector to single-precision format and then destructively multiplies and adds these values without intermediate rounding to the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



Single-precision

```
FMLALT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer index = UInt(i3h:i3l);
boolean op1_neg = FALSE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
<imm>	Is the immediate index, in the range 0 to 7, encoded in the "i3h:i3l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = 2 * segmentbase + index;
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 1, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, s, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

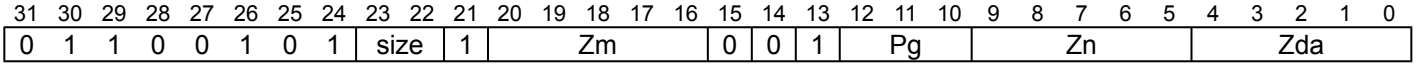
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

FMLS (vectors)

Floating-point fused multiply-subtract vectors (predicated), writing addend [Zda = Zda + -Zn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and subtract from elements of the third source (addend) vector without intermediate rounding. Destructively place the results in the destination and third source (addend) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMLS <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
boolean op3_neg = FALSE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element3;

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMLS (indexed)

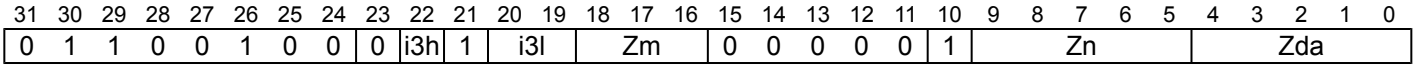
Floating-point fused multiply-subtract by indexed elements (Zda = Zda + -Zn * Zm[indexed]).

Multiply all floating-point elements within each 128-bit segment of the first source vector by the specified element in the corresponding second source vector segment. The products are then destructively subtracted without intermediate rounding from the corresponding elements of the addend and destination vector.

The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element. This instruction is unpredicated.

It has encodings from 3 classes: Half-precision , Single-precision and Double-precision

Half-precision

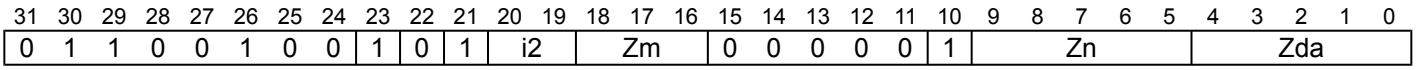


Half-precision

```
FMLS <Zda>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
boolean op3_neg = FALSE;
```

Single-precision

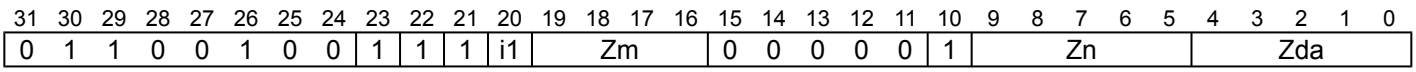


Single-precision

```
FMLS <Zda>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
boolean op3_neg = FALSE;
```

Double-precision



Double-precision

```
FMLS <Zda>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
boolean op3_neg = FALSE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the half-precision and single-precision variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the double-precision variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the half-precision variant: is the immediate index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the single-precision variant: is the immediate index, in the range 0 to 3, encoded in the "i2" field. For the double-precision variant: is the immediate index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, s, esize];
    bits(esize) element3 = Elem[result, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    if op3_neg then element3 = FPNeg(element3);
    Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

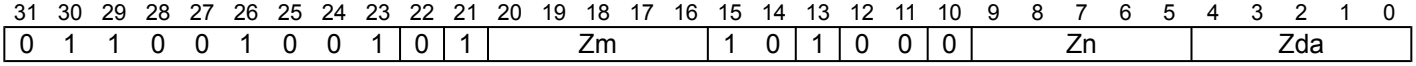
The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

FMLSLB (vectors)

Half-precision floating-point multiply-subtract long from single-precision (bottom).

This half-precision floating-point multiply-subtract long instruction widens the even-numbered 16-bit half-precision elements in the first source vector and the corresponding elements in the second source vector to single-precision format and then destructively multiplies and subtracts these values without intermediate rounding from the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



SVE2

```
FMLSLB <Zda>.S, <Zn>.H, <Zm>.H
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 0, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, 2 * e + 0, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

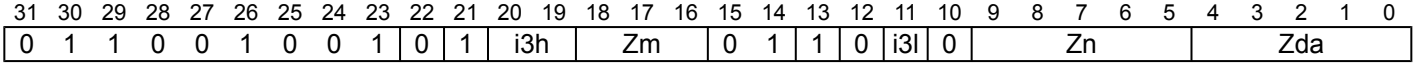
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMLSLB (indexed)

Half-precision floating-point multiply-subtract long from single-precision (bottom, indexed).

This half-precision floating-point multiply-subtract long instruction widens the even-numbered 16-bit half-precision elements in the first source vector and the indexed element from the corresponding 128-bit segment in the second source vector to single-precision format and then destructively multiplies and subtracts these values without intermediate rounding from the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



Single-precision

```
FMLSLB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer index = UInt(i3h:i3l);
boolean op1_neg = TRUE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
<imm>	Is the immediate index, in the range 0 to 7, encoded in the "i3h:i3l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = 2 * segmentbase + index;
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 0, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, s, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

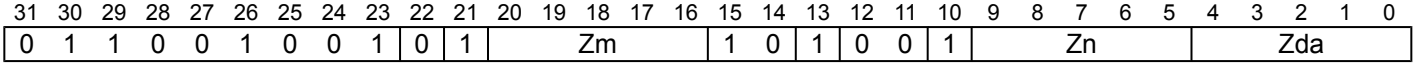
(old) htmldiff from- (new)

(old) htmldiff from- (new)

FMLSLT (vectors)

Half-precision floating-point multiply-subtract long from single-precision (top).

This half-precision floating-point multiply-subtract long instruction widens the odd-numbered 16-bit half-precision elements in the first source vector and the corresponding elements in the second source vector to single-precision format and then destructively multiplies and subtracts these values without intermediate rounding from the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



SVE2

```
FMLSLT <Zda>.S, <Zn>.H, <Zm>.H
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 1, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, 2 * e + 1, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

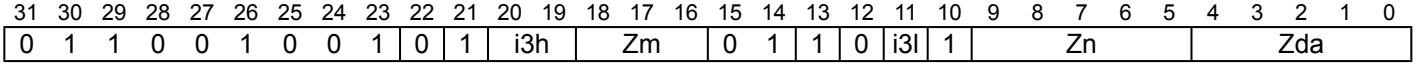
The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

FMLSLT (indexed)

Half-precision floating-point multiply-subtract long from single-precision (top, indexed).

This half-precision floating-point multiply-subtract long instruction widens the odd-numbered 16-bit half-precision elements in the first source vector and the indexed element from the corresponding 128-bit segment in the second source vector to single-precision format and then destructively multiplies and subtracts these values without intermediate rounding from the overlapping 32-bit single-precision elements of the addend and destination vector. This instruction is unpredicated.



Single-precision

```
FMLSLT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer index = UInt(i3h:i3l);
boolean op1_neg = TRUE;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
<imm>	Is the immediate index, in the range 0 to 7, encoded in the "i3h:i3l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = 2 * segmentbase + index;
    bits(esize DIV 2) element1 = Elem[operand1, 2 * e + 1, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, s, esize DIV 2];
    bits(esize) element3 = Elem[operand3, e, esize];
    if op1_neg then element1 = FPNeg(element1);
    Elem[result, e, esize] = FPMulAddH(element3, element1, element2, FPCR);

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

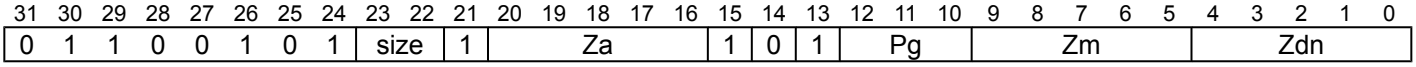
- An unpredicated MOVPRFX instruction.

(old) htmldiff from- (new)

FMSB

Floating-point fused multiply-subtract vectors (predicated), writing multiplicand [Zdn = Za + -Zdn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and subtract from elements of the third (addend) vector without intermediate rounding. Destructively place the results in the destination and first source (multiplicand) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMSB <Zdn>.<T>, <Pg>/M, <Zm>.<T>, <Za>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer a = UInt(Za);
boolean op1_neg = TRUE;
boolean op3_neg = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Za> Is the name of the third source scalable vector register, encoded in the "Za" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[a];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

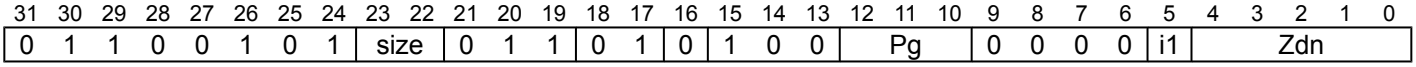
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMUL (immediate)

Floating-point multiply by immediate (predicated).

Multiply by an immediate each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.5 or +2.0 only. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMUL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then FPPointFive('0') else FPTwo('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.5
1	#2.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMul(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

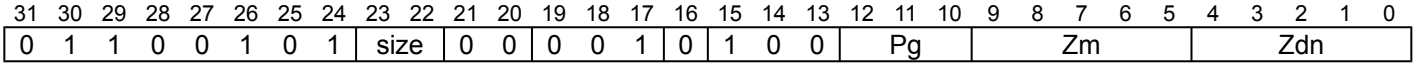
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FMUL (vectors, predicated)

Floating-point multiply vectors (predicated).

Multiply active floating-point elements of the first source vector by corresponding floating-point elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FMUL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMul(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

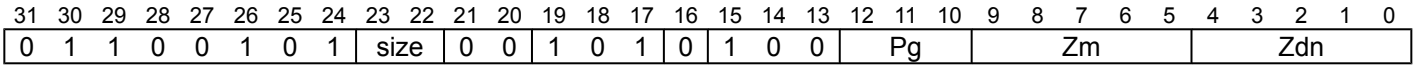
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

FMULX

Floating-point multiply-extended vectors (predicated).

Multiply active floating-point elements of the first source vector by corresponding floating-point elements of the second source vector except that ∞×0.0 gives 2.0 instead of NaN, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.

The instruction can be used with FRECPX to safely convert arbitrary elements in mathematical vector space to UNIT VECTORS or DIRECTION VECTORS with length 1.



SVE

```
FMULX <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPMulX(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

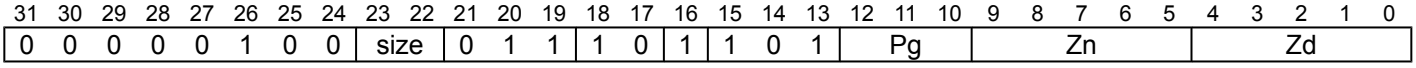
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FNEG

Floating-point negate (predicated).

Negate each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. This inverts the sign bit and cannot signal a floating-point exception. Inactive elements in the destination vector register remain unmodified.



SVE

```
FNEG <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPNeg(element);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

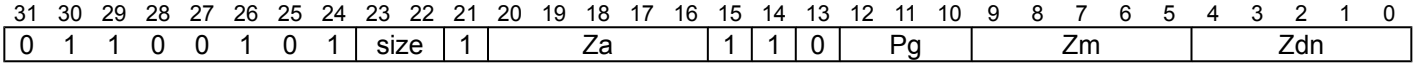
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FNMAD

Floating-point negated fused multiply-add vectors (predicated), writing multiplicand [Zdn = -Za + -Zdn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and add to elements of the third (addend) vector without intermediate rounding. Destructively place the negated results in the destination and first source (multiplicand) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FNMAD <Zdn>.<T>, <Pg>/M, <Zm>.<T>, <Za>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer a = UInt(Za);
boolean op1_neg = TRUE;
boolean op3_neg = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Za> Is the name of the third source scalable vector register, encoded in the "Za" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[a];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

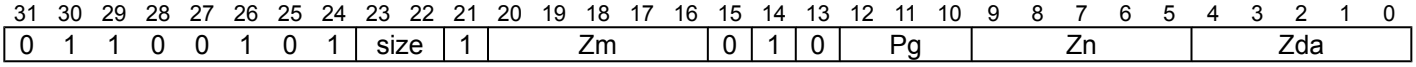
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FNMLA

Floating-point negated fused multiply-add vectors (predicated), writing addend [Zda = -Zda + -Zn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and add to elements of the third source (addend) vector without intermediate rounding. Destructively place the negated results in the destination and third source (addend) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FNMLA <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = TRUE;
boolean op3_neg = TRUE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element3;

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

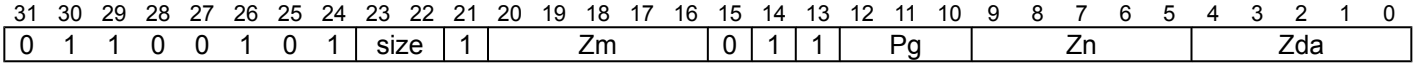
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FNMLS

Floating-point negated fused multiply-subtract vectors (predicated), writing addend [Zda = -Zda + Zn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and subtract from elements of the third source (addend) vector without intermediate rounding. Destructively place the negated results in the destination and third source (addend) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FNMLS <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean op1_neg = FALSE;
boolean op3_neg = TRUE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element3;

Z[da] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

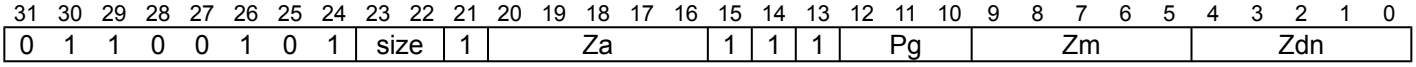
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FNMSB

Floating-point negated fused multiply-subtract vectors (predicated), writing multiplicand [Zdn = -Za + Zdn * Zm].

Multiply the corresponding active floating-point elements of the first and second source vectors and subtract from elements of the third (addend) vector without intermediate rounding. Destructively place the negated results in the destination and first source (multiplicand) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FNMSB <Zdn>.<T>, <Pg>/M, <Zm>.<T>, <Za>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer a = UInt(Za);
boolean op1_neg = FALSE;
boolean op3_neg = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Za> Is the name of the third source scalable vector register, encoded in the "Za" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[a];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    bits(esize) element3 = Elem[operand3, e, esize];

    if ElemP[mask, e, esize] == '1' then
        if op1_neg then element1 = FPNeg(element1);
        if op3_neg then element3 = FPNeg(element3);
        Elem[result, e, esize] = FPMulAdd(element3, element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

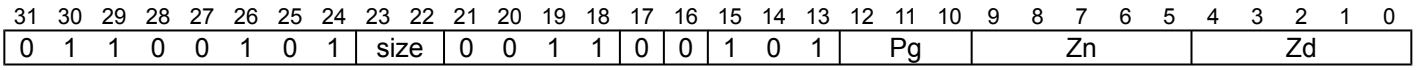
(old) htmldiff from- (new)

FRECPX

Floating-point reciprocal exponent (predicated).

Invert the exponent leaving the fractional part unchanged of each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.

The result of this instruction can be used with FMULX to convert arbitrary elements in mathematical vector space to "unit vectors" or "direction vectors" of length 1.



SVE

```
FRECPX <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPRecpX(element, FPCR);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

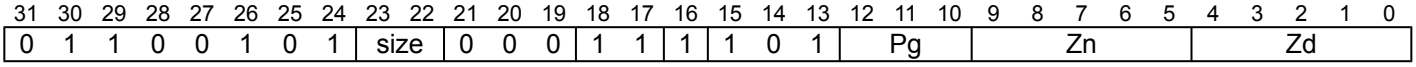
FRINT<r>

Floating-point round to integral value (predicated).

Round to an integral floating-point value with the specified rounding option from each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
The <r> symbol specifies one of the following rounding options: N (to nearest, with ties to even), A (to nearest, with ties away from zero), M (toward minus Infinity), P (toward plus Infinity), Z (toward zero), I (current FPCR rounding mode), or X (current FPCR rounding mode, signalling inexact).

It has encodings from 7 classes: Current mode , Current mode signalling inexact , Nearest with ties to away , Nearest with ties to even , Toward zero , Toward minus infinity and Toward plus infinity

Current mode

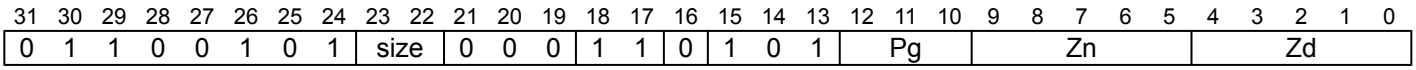


Current mode

```
FRINTI <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

Current mode signalling inexact

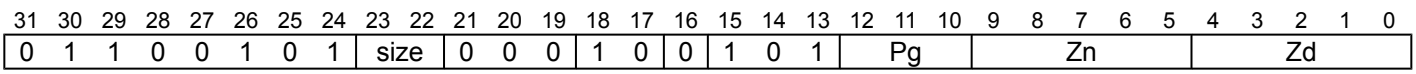


Current mode signalling inexact

```
FRINTX <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

Nearest with ties to away

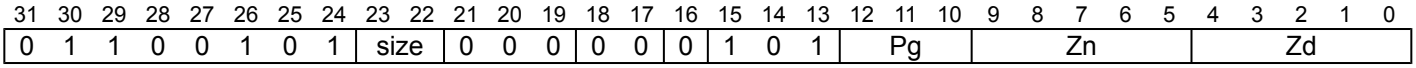


Nearest with ties to away

```
FRINTA <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = FALSE;
FPRounding rounding = FPRounding_TIEAWAY;
```

Nearest with ties to even

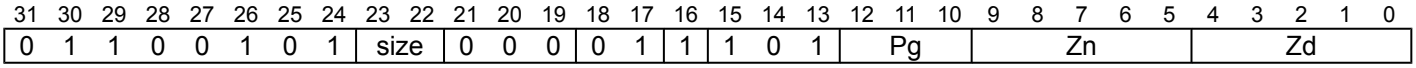


Nearest with ties to even

```
FRINTN <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = FALSE;
FPRounding rounding = FPRounding_TIEEVEN;
```

Toward zero

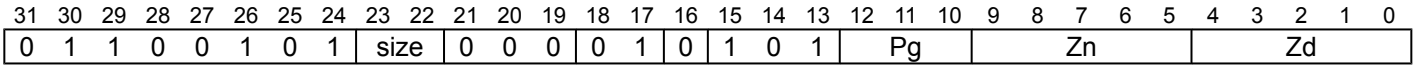


Toward zero

```
FRINTZ <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = FALSE;
FPRounding rounding = FPRounding_ZERO;
```

Toward minus infinity

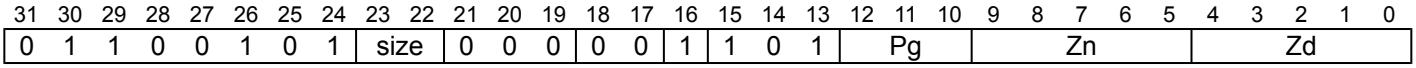


Toward minus infinity

```
FRINTM <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = FALSE;
FPRounding rounding = FPRounding_NEGINF;
```

Toward plus infinity



Toward plus infinity

```
FRINTP <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean exact = FALSE;
FPRounding rounding = FPRounding_POSINF;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPRoundInt(element, FPCR, rounding, exact);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

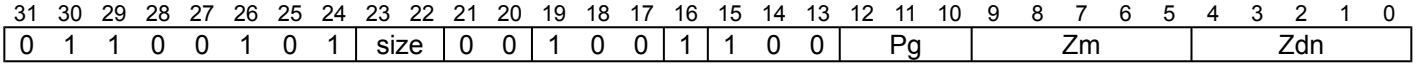
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FSCALE

Floating-point adjust exponent by vector (predicated).

Multiply the active floating-point elements of the first source vector by 2.0 to the power of the signed integer values in the corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FSCALE <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPScale(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

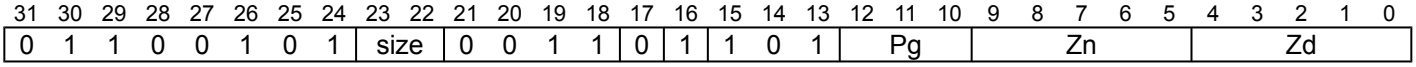
(old) htmldiff from- (new)

(old) htmldiff from- (new)

FSQRT

Floating-point square root (predicated).

Calculate the square root of each active floating-point element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FSQRT <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPSqrt(element, FPCR);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

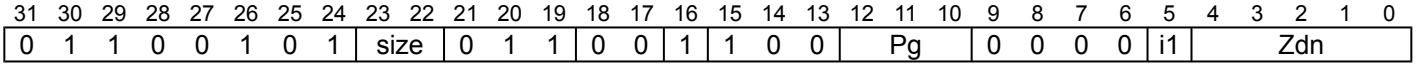
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FSUB (immediate)

Floating-point subtract immediate (predicated).

Subtract an immediate from each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.5 or +1.0 only. Inactive elements in the destination vector register remain unmodified.



SVE

```
FSUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then FPPointFive('0') else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.5
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPSub(element1, imm, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

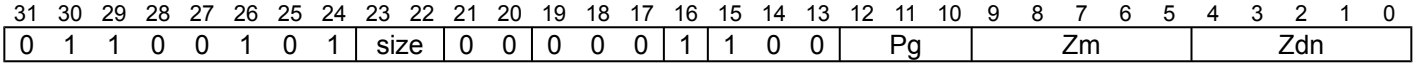
(old) htmldiff from- (new)

(old) htmldiff from- (new)

FSUB (vectors, predicated)

Floating-point subtract vectors (predicated).

Subtract active floating-point elements of the second source vector from corresponding floating-point elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FSUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPSub(element1, element2, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

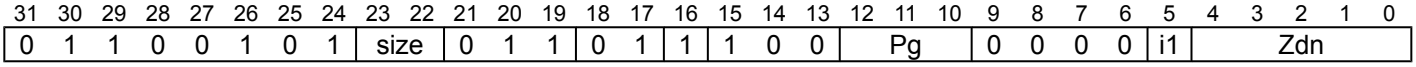
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

FSUBR (immediate)

Floating-point reversed subtract from immediate (predicated).

Reversed subtract from an immediate each active floating-point element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate may take the value +0.5 or +1.0 only. Inactive elements in the destination vector register remain unmodified.



SVE

```
FSUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <const>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
bits(esize) imm = if i1 == '0' then FPPointFive('0') else FPOne('0');
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the floating-point immediate value, encoded in “i1”:

i1	<const>
0	#0.5
1	#1.0

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPSub(imm, element1, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

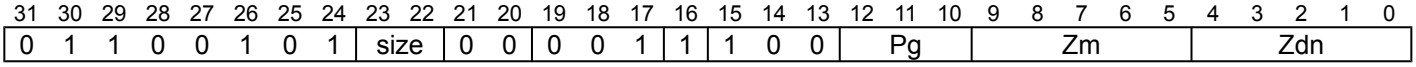
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FSUBR (vectors)

Floating-point reversed subtract vectors (predicated).

Reversed subtract active floating-point elements of the first source vector from corresponding floating-point elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
FSUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = FPSub(element2, element1, FPCR);
    else
        Elem[result, e, esize] = element1;

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.

- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

FTMAD

Floating-point trigonometric multiply-add coefficient.

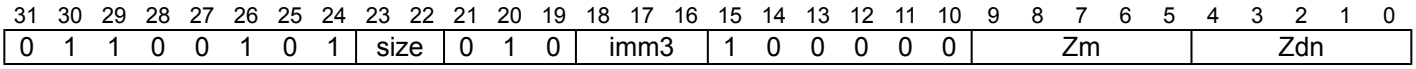
The FTMAD instruction calculates the series terms for either SIN(X) or COS(X), where the argument X has been adjusted to be in the range $-\pi/4 < X \leq \pi/4$.

To calculate the series terms of SIN(X) and COS(X) the initial source operands of FTMAD should be zero in the first source vector and X^2 in the second source vector. The FTMAD instruction is then executed eight times to calculate the sum of eight series terms, which gives a result of sufficient precision.

The FTMAD instruction multiplies each element of the first source vector by the absolute value of the corresponding element of the second source vector and performs a fused addition of each product with a value obtained from a table of hard-wired coefficients, and places the results destructively in the first source vector.

The coefficients are different for SIN(X) and COS(X), and are selected by a combination of the sign bit in the second source element and an immediate index in the range 0 to 7.

This instruction is unpredicated.



SVE

```
FTMAD <Zdn>.<T>, <Zdn>.<T>, <Zm>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer imm = UInt(imm3);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<imm> Is the unsigned immediate operand, in the range 0 to 7, encoded in the "imm3" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    Elem[result, e, esize] = FPTrigMAdd(imm, element1, element2, FPCR);

Z[dn] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

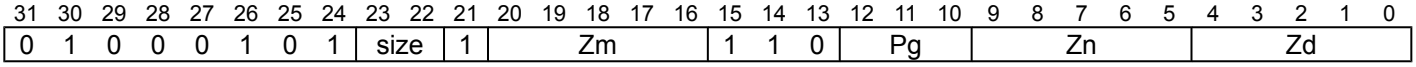
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

HISTCNT

Count matching elements in vector.

This instruction compares each active 32 or 64-bit element of the first source vector with all active elements with an element number less than or equal to its own in the second source vector, and places the count of matching elements in the corresponding element of the destination vector. Inactive elements in the destination vector are set to zero.



SVE2

```
HISTCNT <Zd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer d = UInt(Zd);
integer n = UInt(Zn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer count = 0;
    if ElemP[mask, e, esize] == '1' then
        bits(esize) element1 = Elem[operand1, e, esize];
        for i = 0 to e
            if ElemP[mask, i, esize] == '1' then
                bits(esize) element2 = Elem[operand2, i, esize];
                if element1 == element2 then
                    count = count + 1;
    Elem[result, e, esize] = count<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

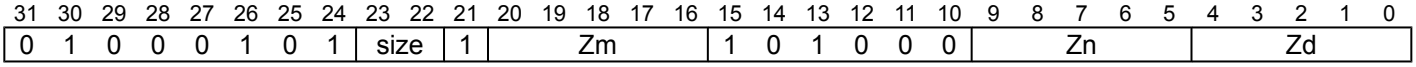
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

HISTSEG

Count matching elements in vector segments.

This instruction compares each 8-bit byte element of the first source vector with all of the elements in the corresponding 128-bit segment of the second source vector and places the count of matching elements in the corresponding element of the destination vector. This instruction is unpredicated.



SVE2

```
HISTSEG <Zd>.B, <Zn>.B, <Zm>.B
```

```
if !HaveSVE2() then UNDEFINED;
if size != '00' then UNDEFINED;
integer esize = 8;
integer d = UInt(Zd);
integer n = UInt(Zn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for b = 0 to segments-1
    for s = 0 to eltspersegment-1
        integer count = 0;
        integer e = eltspersegment * b + s;
        bits(esize) element1 = Elem[operand1, e, esize];
        for i = 0 to eltspersegment-1
            integer e2 = eltspersegment * b + i;
            bits(esize) element2 = Elem[operand2, e2, esize];
            if element1 == element2 then
                count = count + 1;
        Elem[result, e, esize] = count<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

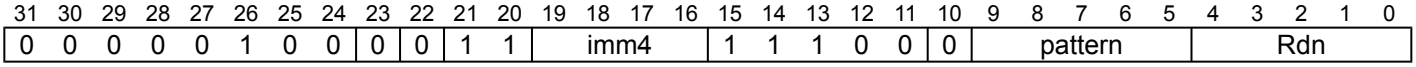
INCB, INCD, INCH, INCW (scalar)

Increment scalar by multiple of predicate constraint element count.

Determines the number of active elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 4 classes: Byte , Doubleword , Halfword and Word

Byte

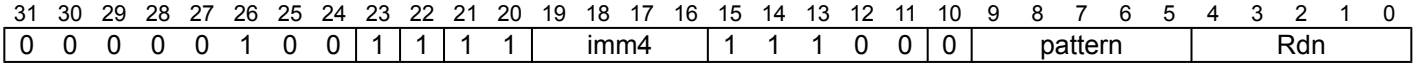


Byte

```
INCB <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Doubleword

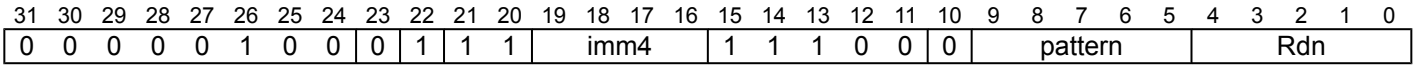


Doubleword

```
INCD <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Halfword

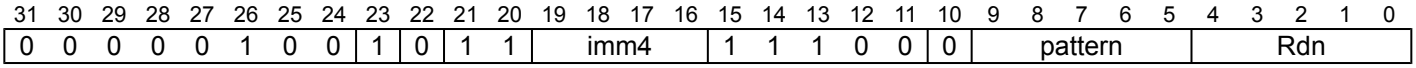


Halfword

```
INCH <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Word



Word

```
INCW <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(64) operand1 = X[dn];

X[dn] = operand1 + (count * imm);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

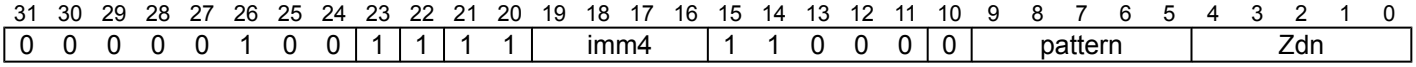
INCD, INCH, INCW (vector)

Increment vector by multiple of predicate constraint element count.

Determines the number of active elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 3 classes: Doubleword , Halfword and Word

Doubleword

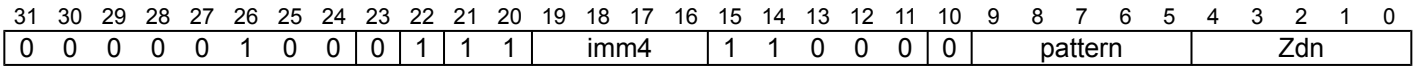


Doubleword

```
INCD <Zdn>.D{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Halfword

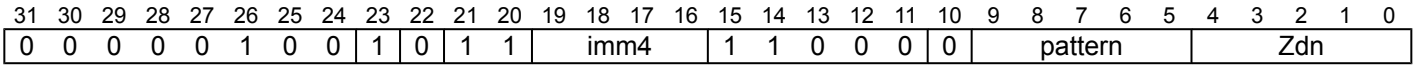


Halfword

```
INCH <Zdn>.H{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Word



Word

```
INCW <Zdn>.S{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    Elem[result, e, esize] = Elem[operand1, e, esize] + (count * imm);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

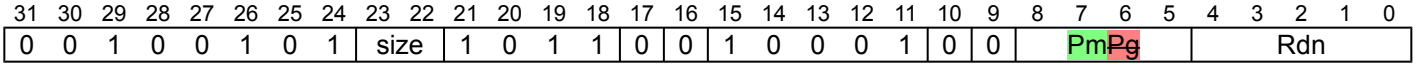
(old) htmldiff from- (new)

(old) htmldiff from- (new)

INCP (scalar)

Increment scalar by countactive ofpredicate trueelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to increment the scalar destination.



SVE

```
INCP <Xdn>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(64) operand1 =bits(PL) mask = P[g];
bits(64) operand = X[dn];
bits(PL) operand2 = P[m];
[dn];
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

X[dn] = operand1 + count;[dn] = operand + count;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

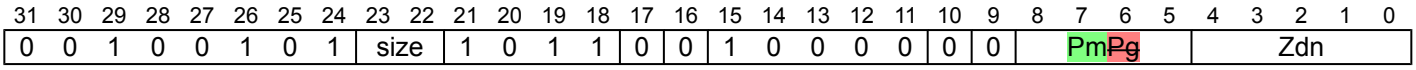
(old) htmldiff from- (new)

(old) htmldiff from- (new)

INCP (vector)

Increment vector by countactive ofpredicate trueelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to increment all destination vector elements.
The predicate size specifier may be omitted in assembler source code, but this is deprecated and will be prohibited in a future release of the architecture.



SVE

```
INCP <Zdn>.<T>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 =bits(PL) mask = P[g];
bits(VL) operand = Z[dn];
bits(PL) operand2 = P[m];
[dn];
bits(VL) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

for e = 0 to elements-1
    Elem[result, e, esize] = Elem[operand1, e, esize] + count;[operand, e, esize] + count;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

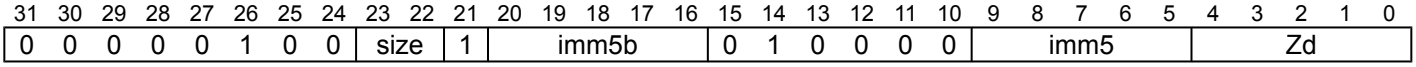
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future_20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

INDEX (immediates)

Create index starting from and incremented by immediate.

Populates the destination vector by setting the first element to the first signed immediate integer operand and monotonically incrementing the value by the second signed immediate integer operand for each subsequent element. This instruction is unpredicated.



SVE

```
INDEX <Zd>.<T>, #<imm1>, #<imm2>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer d = UInt(Zd);
integer imm1 = SInt(imm5);
integer imm2 = SInt(imm5b);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm1> Is the first signed immediate operand, in the range -16 to 15, encoded in the "imm5" field.

<imm2> Is the second signed immediate operand, in the range -16 to 15, encoded in the "imm5b" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) result;

for e = 0 to elements-1
    integer index = imm1 + e * imm2;
    Elem[result, e, esize] = index<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

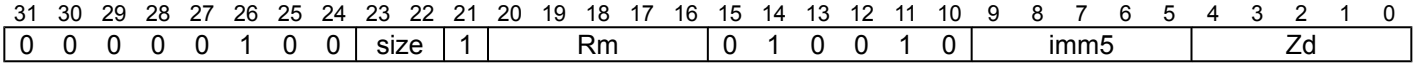
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

INDEX (immediate, scalar)

Create index starting from immediate and incremented by general-purpose register.

Populates the destination vector by setting the first element to the first signed immediate integer operand and monotonically incrementing the value by the second signed scalar integer operand for each subsequent element. The scalar source operand is a general-purpose register in which only the least significant bits corresponding to the vector element size are used and any remaining bits are ignored. This instruction is unpredicated.



SVE

```
INDEX <Zd>.<T>, #<imm>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m = UInt(Rm);
integer d = UInt(Zd);
integer imm = SInt(imm5);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is the signed immediate operand, in the range -16 to 15, encoded in the "imm5" field.

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(esize) operand2 = X[m];
integer element2 = SInt(operand2);
bits(VL) result;

for e = 0 to elements-1
    integer index = imm + e * element2;
    Elem[result, e, esize] = index<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

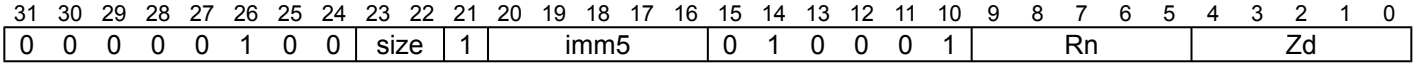
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

INDEX (scalar, immediate)

Create index starting from general-purpose register and incremented by immediate.

Populates the destination vector by setting the first element to the first signed scalar integer operand and monotonically incrementing the value by the second signed immediate integer operand for each subsequent element. The scalar source operand is a general-purpose register in which only the least significant bits corresponding to the vector element size are used and any remaining bits are ignored. This instruction is unpredicated.



SVE

```
INDEX <Zd>.<T>, <R><n>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Rn);
integer d = UInt(Zd);
integer imm = SInt(imm5);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<imm> Is the signed immediate operand, in the range -16 to 15, encoded in the "imm5" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(esize) operand1 = X[n];
integer element1 = SInt(operand1);
bits(VL) result;

for e = 0 to elements-1
    integer index = element1 + e * imm;
    Elem[result, e, esize] = index<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

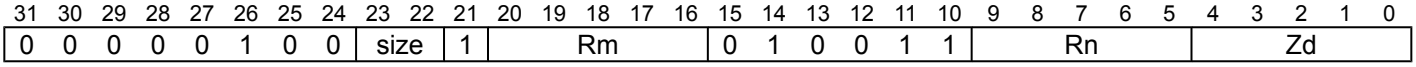
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

INDEX (scalars)

Create index starting from and incremented by general-purpose register.

Populates the destination vector by setting the first element to the first signed scalar integer operand and monotonically incrementing the value by the second signed scalar integer operand for each subsequent element. The scalar source operands are general-purpose registers in which only the least significant bits corresponding to the vector element size are used and any remaining bits are ignored. This instruction is unpredicated.



SVE

```
INDEX <Zd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(esize) operand1 = X[n];
integer element1 = SInt(operand1);
bits(esize) operand2 = X[m];
integer element2 = SInt(operand2);
bits(VL) result;

for e = 0 to elements-1
    integer index = element1 + e * element2;
    Elem[result, e, esize] = index<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

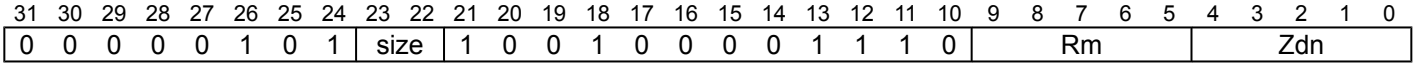
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

INSR (scalar)

Insert general-purpose register in shifted vector.

Shift the destination vector left by one element, and then place a copy of the least-significant bits of the general-purpose register in element 0 of the destination vector. This instruction is unpredicated.



SVE

```
INSR <Zdn>.<T>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer m = UInt(Rm);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
bits(VL) dest = Z[dn];
bits(esize) src = X[m];
Z[dn] = dest<VL-esize-1:0> : src;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

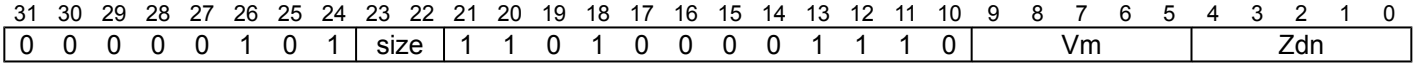
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

INSR (SIMD&FP scalar)

Insert SIMD&FP scalar register in shifted vector.

Shift the destination vector left by one element, and then place a copy of the SIMD&FP scalar register in element 0 of the destination vector. This instruction is unpredicated.



SVE

```
INSR <Zdn>.<T>, <V><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer m = UInt(Vm);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<m> Is the number [0-31] of the source SIMD&FP register, encoded in the "Vm" field.

Operation

```
CheckSVEEnabled();
bits(VL) dest = Z[dn];
bits(esize) src = V[m];
Z[dn] = dest<VL-esize-1:0> : src;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

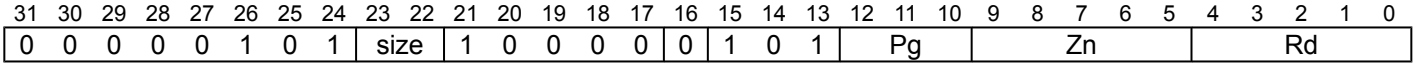
The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

LASTA (scalar)

Extract element after last to general-purpose register.

If there is an active element then extract the element after the last active element modulo the number of elements from the final source vector register. If there are no active elements, extract element zero. Then zero-extend and place the extracted element in the destination general-purpose register.



SVE

```
LASTA <R><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = if esize < 64 then 32 else 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Rd);
boolean isBefore = FALSE;
```

Assembler Symbols

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<d> Is the number [0-30] of the destination general-purpose register or the name ZR (31), encoded in the "Rd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(rsize) result;
integer last = LastActiveElement(mask, esize);

if isBefore then
    if last < 0 then last = elements - 1;
else
    last = last + 1;
    if last >= elements then last = 0;
result = ZeroExtend(Elem[operand, last, esize]);

X[d] = result;
```

Operational information

If PSTATE.DIT is 1:

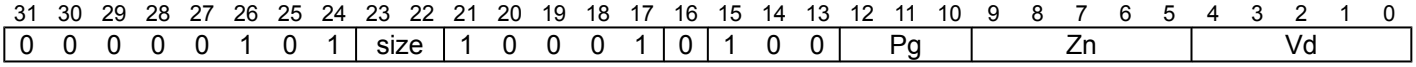
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LASTA (SIMD&FP scalar)

Extract element after last to SIMD&FP scalar register.

If there is an active element then extract the element after the last active element modulo the number of elements from the final source vector register. If there are no active elements, extract element zero. Then place the extracted element in the destination SIMD&FP scalar register.



SVE

```
LASTA <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
boolean isBefore = FALSE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer last = LastActiveElement(mask, esize);

if isBefore then
    if last < 0 then last = elements - 1;
else
    last = last + 1;
    if last >= elements then last = 0;
V[d] = Elem[operand, last, esize];
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

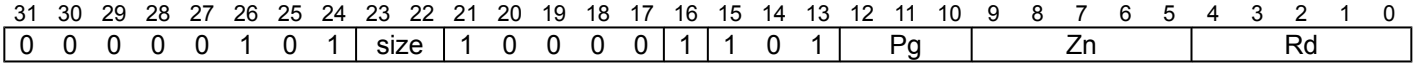
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LASTB (scalar)

Extract last element to general-purpose register.

If there is an active element then extract the last active element from the final source vector register. If there are no active elements, extract the highest-numbered element. Then zero-extend and place the extracted element in the destination general-purpose register.



SVE

```
LASTB <R><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = if esize < 64 then 32 else 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Rd);
boolean isBefore = TRUE;
```

Assembler Symbols

<R> Is a width specifier, encoded in “size”:

size	<R>
01	W
x0	W
11	X

<d> Is the number [0-30] of the destination general-purpose register or the name ZR (31), encoded in the "Rd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(rsize) result;
integer last = LastActiveElement(mask, esize);

if isBefore then
    if last < 0 then last = elements - 1;
else
    last = last + 1;
    if last >= elements then last = 0;
result = ZeroExtend(Elem[operand, last, esize]);

X[d] = result;
```

Operational information

If PSTATE.DIT is 1:

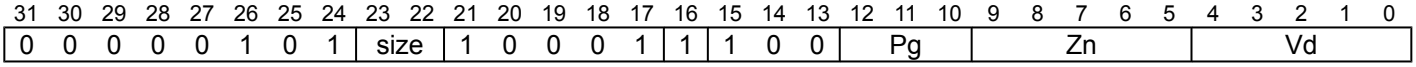
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LASTB (SIMD&FP scalar)

Extract last element to SIMD&FP scalar register.

If there is an active element then extract the last active element from the final source vector register. If there are no active elements, extract the highest-numbered element. Then place the extracted element in the destination SIMD&FP register.



SVE

```
LASTB <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
boolean isBefore = TRUE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer last = LastActiveElement(mask, esize);

if isBefore then
    if last < 0 then last = elements - 1;
else
    last = last + 1;
    if last >= elements then last = 0;
V[d] = Elem[operand, last, esize];
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

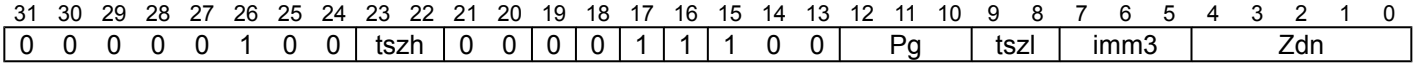
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LSL (immediate, predicated)

Logical shift left by immediate (predicated).

Shift left by immediate each active element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSL(element1, shift);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

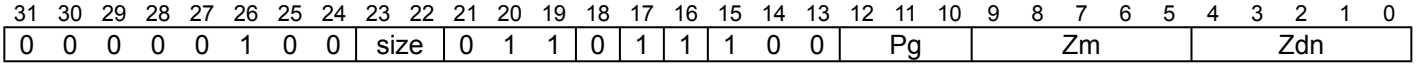
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSL (wide elements, predicated)

Logical shift left by 64-bit wide elements (predicated).

Shift left active elements of the first source vector by corresponding overlapping 64-bit elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount is a vector of unsigned 64-bit doubleword elements in which all bits are significant, and not used modulo the destination element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(64) element2 = integer element2 = UInt(Elem[operand2, (e * esize) DIV 64, 64];
    integer shift = Min(UInt(element2), esize);
[operand2, (e * esize) DIV 64, 64]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSL(element1, shift);
(element1, element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and destination element size as this instruction.

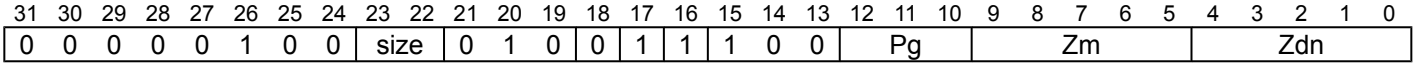
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSL (vectors)

Logical shift left by vector (predicated).

Shift left active elements of the first source vector by corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount operand is a vector of unsigned elements in which all bits are significant, and not used modulo the element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = integer element2 = UInt(Elem[operand2, e, esize];
    integer shift = Min(UInt(element2), esize);
[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSL(element1, shift);
(element1, element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

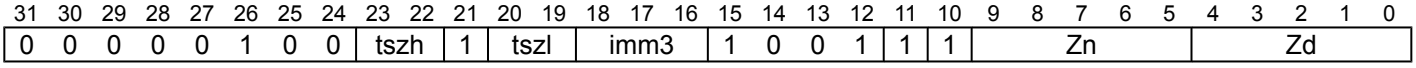
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSL (immediate, unpredicated)

Logical shift left by immediate (unpredicated).

Shift left by immediate each element of the source vector, and place the results in the corresponding elements of the destination vector. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. This instruction is unpredicated.



SVE

```
LSL <Zd>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    Elem[result, e, esize] = LSL(element1, shift);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

- The values of the data supplied in any of its registers.
- The values of the NZCV flags.

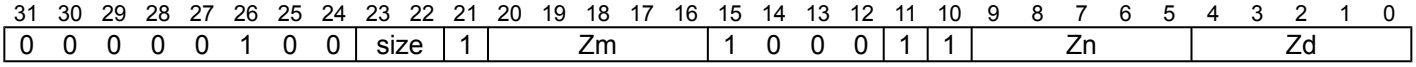
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSL (wide elements, unpredicated)

Logical shift left by 64-bit wide elements (unpredicated).

Shift left all elements of the first source vector by corresponding overlapping 64-bit elements of the second source vector and place the first in the corresponding elements of the destination vector. The shift amount is a vector of unsigned 64-bit doubleword elements in which all bits are significant, and not used modulo the destination element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSL <Zd>.<T>, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(64) element2 = integer element2 = UInt(Elem[operand2, (e * esize) DIV 64, 64];
    integer shift = Min(UInt(element2), esize);[operand2, (e * esize) DIV 64, 64]);
    Elem[result, e, esize] = LSL(element1, shift);(element1, element2);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

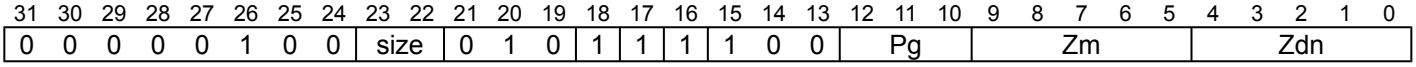
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

LSLR

Reversed logical shift left by vector (predicated).

Reversed shift left active elements of the second source vector by corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount operand is a vector of unsigned elements in which all bits are significant, and not used modulo the element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = integer element1 = UInt(Elem[operand1, e, esize];
[operand1, e, esize]);
    bits(esize) element2 = Elem[operand2, e, esize];
    integer shift = Min(UInt(element1), esize);
[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSL(element2, shift);
(element2, element1);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

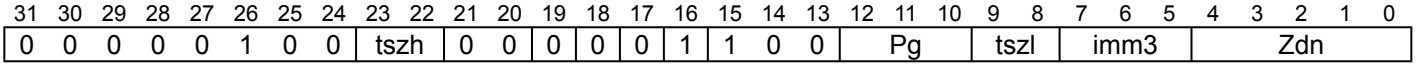
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSR (immediate, predicated)

Logical shift right by immediate (predicated).

Shift right by immediate, inserting zeroes, each active element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSR(element1, shift);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

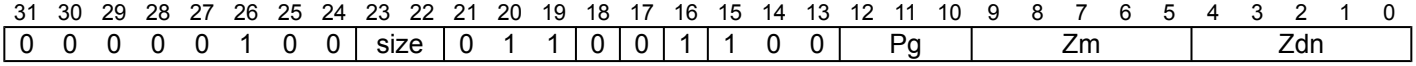
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

LSR (wide elements, predicated)

Logical shift right by 64-bit wide elements (predicated).

Shift right, inserting zeroes, active elements of the first source vector by corresponding overlapping 64-bit elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount is a vector of unsigned 64-bit doubleword elements in which all bits are significant, and not used modulo the destination element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(64) element2 = integer element2 = UInt(Elem[operand2, (e * esize) DIV 64, 64];
    integer shift = Min(UInt(element2), esize);
[operand2, (e * esize) DIV 64, 64]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSR(element1, shift);
(element1, element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and destination element size as this instruction.

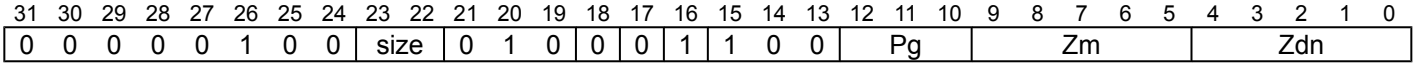
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSR (vectors)

Logical shift right by vector (predicated).

Shift right, inserting zeroes, active elements of the first source vector by corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount operand is a vector of unsigned elements in which all bits are significant, and not used modulo the element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = integer element2 = UInt(Elem[operand2, e, esize];
    integer shift = Min(UInt(element2), esize);
[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSR(element1, shift);
(element1, element2);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

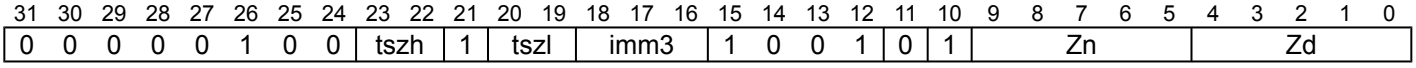
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSR (immediate, unpredicated)

Logical shift right by immediate (unpredicated).

Shift right by immediate, inserting zeroes, each element of the source vector, and place the results in the corresponding elements of the destination vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE

```
LSR <Zd>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    Elem[result, e, esize] = LSR(element1, shift);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

- The values of the data supplied in any of its registers.
- The values of the NZCV flags.

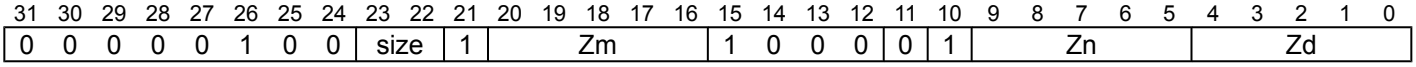
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

LSR (wide elements, unpredicated)

Logical shift right by 64-bit wide elements (unpredicated).

Shift right, inserting zeroes, all elements of the first source vector by corresponding overlapping 64-bit elements of the second source vector and place the first in the corresponding elements of the destination vector. The shift amount is a vector of unsigned 64-bit doubleword elements in which all bits are significant, and not used modulo the destination element size. This instruction is unpredicated.



SVE

```
LSR <Zd>.<T>, <Zn>.<T>, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(64) element2 = integer element2 = UInt(Elem[operand2, (e * esize) DIV 64, 64];
    integer shift = Min(UInt(element2), esize);[operand2, (e * esize) DIV 64, 64]);
    Elem[result, e, esize] = LSR(element1, shift);(element1, element2);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

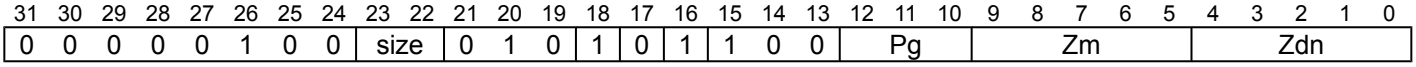
(old) htmldiff from- (new)

(old) htmldiff from- (new)

LSRR

Reversed logical shift right by vector (predicated).

Reversed shift right, inserting zeroes, active elements of the second source vector by corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. The shift amount operand is a vector of unsigned elements in which all bits are significant, and not used modulo the element size. Inactive elements in the destination vector register remain unmodified.



SVE

```
LSRR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 =     integer element1 = UInt(Elem[operand1, e, esize];
[operand1, e, esize]);
    bits(esize) element2 = Elem[operand2, e, esize];
    integer shift = Min(UInt(element1), esize);
[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = LSR(element2, shift);
(element2, element1);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

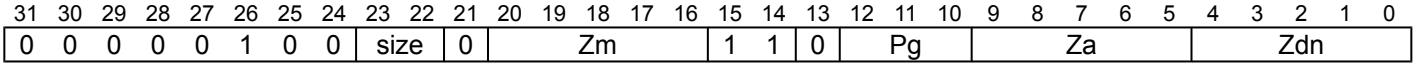
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

MAD

Multiply-add vectors (predicated), writing multiplicand [Zdn = Za + Zdn * Zm].

Multiply the corresponding active elements of the first and second source vectors and add to elements of the third (addend) vector. Destructively place the results in the destination and first source (multiplicand) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
MAD <Zdn>.<T>, <Pg>/M, <Zm>.<T>, <Za>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer a = UInt(Za);
boolean sub_op = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Za> Is the name of the third source scalable vector register, encoded in the "Za" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[a];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer product = element1 * element2;
        if sub_op then
            Elem[result, e, esize] = Elem[operand3, e, esize] - product;
        else
            Elem[result, e, esize] = Elem[operand3, e, esize] + product;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

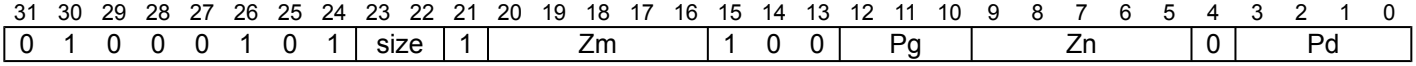
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

MATCH

Detect any matching elements, setting the condition flags.

This instruction compares each active 8-bit or 16-bit character in the first source vector with all of the characters in the corresponding 128-bit segment of the second source vector. Where the first source element detects any matching characters in the second segment it places true in the corresponding element of the destination predicate, otherwise false. Inactive elements in the destination predicate register are set to zero. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
MATCH <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '1x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer d = UInt(Pd);
integer n = UInt(Zn);
integer m = UInt(Zm);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	B
1	H

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(PL) result;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer segmentbase = e - e MOD eltspersegment;
        ElemP[result, e, esize] = '0';
        bits(esize) element1 = Elem[operand1, e, esize];
        for i = segmentbase to segmentbase + eltspersegment - 1
            bits(esize) element2 = Elem[operand2, i, esize];
            if element1 == element2 then
                ElemP[result, e, esize] = '1';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

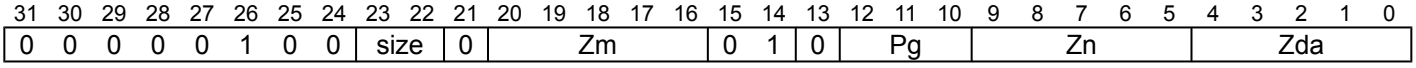
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

MLA (vectors)

Multiply-add vectors (predicated), writing addend [Zda = Zda + Zn * Zm].

Multiply the corresponding active elements of the first and second source vectors and add to elements of the third source (addend) vector. Destructively place the results in the destination and third source (addend) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
MLA <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean sub_op = FALSE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer product = element1 * element2;
        if sub_op then
            Elem[result, e, esize] = Elem[operand3, e, esize] - product;
        else
            Elem[result, e, esize] = Elem[operand3, e, esize] + product;
    else
        Elem[result, e, esize] = Elem[operand3, e, esize];

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

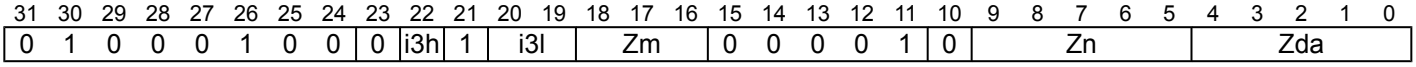
MLA (indexed)

Multiply-add to accumulator (indexed).

Multiply all integer elements within each 128-bit segment of the first source vector by the specified element in the corresponding second source vector segment. The products are then destructively added to the corresponding elements of the addend and destination vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element. This instruction is unpredicated.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

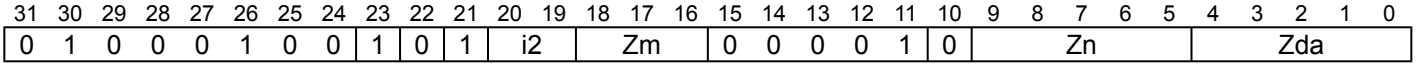


16-bit

```
MLA <Zda>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

32-bit

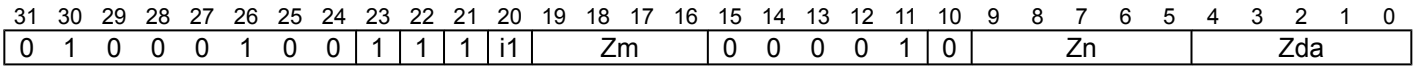


32-bit

```
MLA <Zda>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

64-bit



64-bit

```
MLA <Zda>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, s, esize]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

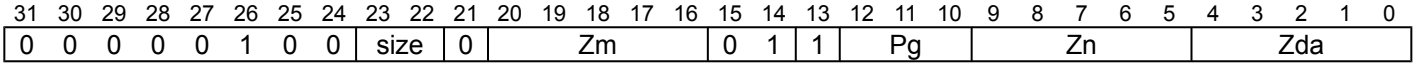
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

MLS (vectors)

Multiply-subtract vectors (predicated), writing addend [Zda = Zda - Zn * Zm].

Multiply the corresponding active elements of the first and second source vectors and subtract from elements of the third source (addend) vector. Destructively place the results in the destination and third source (addend) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
MLS <Zda>.<T>, <Pg>/M, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean sub_op = TRUE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer product = element1 * element2;
        if sub_op then
            Elem[result, e, esize] = Elem[operand3, e, esize] - product;
        else
            Elem[result, e, esize] = Elem[operand3, e, esize] + product;
    else
        Elem[result, e, esize] = Elem[operand3, e, esize];

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

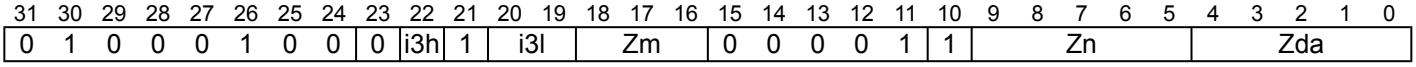
MLS (indexed)

Multiply-subtract from accumulator (indexed).

Multiply all integer elements within each 128-bit segment of the first source vector by the specified element in the corresponding second source vector segment. The products are then destructively subtracted from the corresponding elements of the addend and destination vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element. This instruction is unpredicated.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

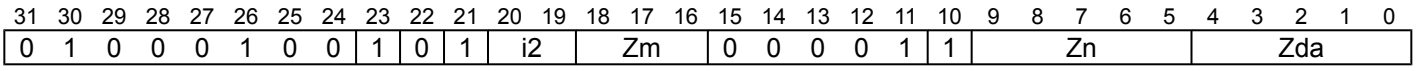


16-bit

```
MLS <Zda>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

32-bit

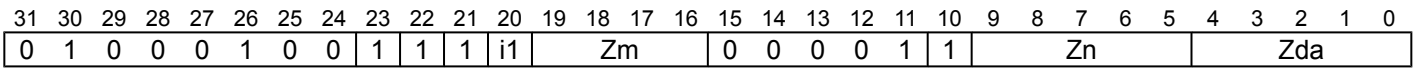


32-bit

```
MLS <Zda>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

64-bit



64-bit

```
MLS <Zda>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, s, esize]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

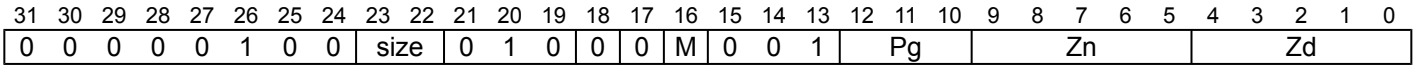
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

MOVPRFX (predicated)

Move prefix (predicated).

The predicated MOVPRFX instruction is a hint to hardware that the instruction may be combined with the destructive instruction which follows it in program order to create a single constructive operation. Since it is a hint it is also permitted to be implemented as a discrete vector copy, and the result of executing the pair of instructions with or without combining is identical. The choice of combined versus discrete operation may vary dynamically. Although the operation of the instruction is defined as a simple predicated vector copy, it is required that the prefixed instruction at PC+4 must be an SVE destructive binary or ternary instruction encoding, or a unary operation with merging predication, but excluding other MOVPRFX instructions. The prefixed instruction must specify the same predicate register, and have the same maximum element size (ignoring a fixed 64-bit "wide vector" operand), and the same destination vector as the MOVPRFX instruction. The prefixed instruction must not use the destination register in any other operand position, even if they have different names but refer to the same architectural register state. Any other use is UNPREDICTABLE.



SVE

```
MOVPRFX <Zd>.<T>, <Pg>/<ZM>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean merging = (M == '1');
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<ZM> Is the predication qualifier, encoded in “M”:

M	<ZM>
0	Z
1	M

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) dest = Z[d];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element = Elem[operand1, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element;
    elsif merging then
        Elem[result, e, esize] = Elem[dest, e, esize];
    else
        Elem[result, e, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

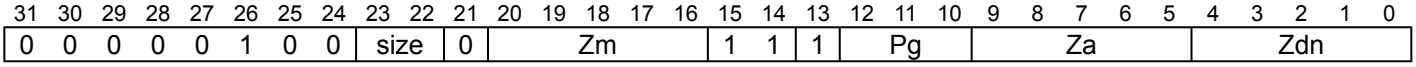
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

MSB

Multiply-subtract vectors (predicated), writing multiplicand [Zdn = Za - Zdn * Zm].

Multiply the corresponding active elements of the first and second source vectors and subtract from elements of the third (addend) vector. Destructively place the results in the destination and first source (multiplicand) vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
MSB <Zdn>.<T>, <Pg>/M, <Zm>.<T>, <Za>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
integer a = UInt(Za);
boolean sub_op = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Za> Is the name of the third source scalable vector register, encoded in the "Za" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[a];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer product = element1 * element2;
        if sub_op then
            Elem[result, e, esize] = Elem[operand3, e, esize] - product;
        else
            Elem[result, e, esize] = Elem[operand3, e, esize] + product;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

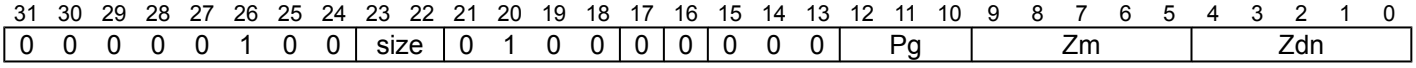
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

MUL (vectors, predicated)

Multiply vectors (predicated).

Multiply active elements of the first source vector by corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
MUL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer product = element1 * element2;
        Elem[result, e, esize] = product<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

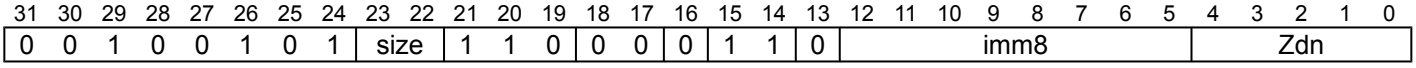
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

MUL (immediate)

Multiply by immediate (unpredicated).

Multiply by an immediate each element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is a signed 8-bit value in the range -128 to +127, inclusive. This instruction is unpredicated.



SVE

```
MUL <Zdn>.<T>, <Zdn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = SInt(imm8);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is the signed immediate operand, in the range -128 to 127, encoded in the "imm8" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    Elem[result, e, esize] = (element1 * imm)<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

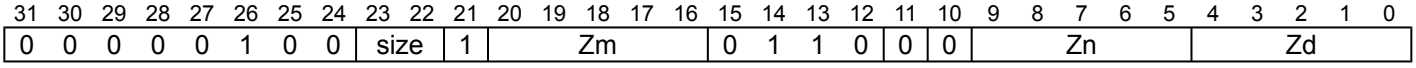
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

MUL (vectors, unpredicated)

Multiply vectors (unpredicated).

Multiply all elements of the first source vector by corresponding elements of the second source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
MUL <Zd>.<T>, <Zn>.<T>, <Zm>.<T>

if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer product = element1 * element2;
    Elem[result, e, esize] = product<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

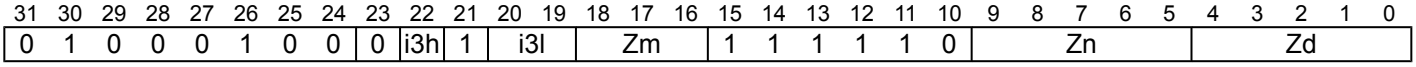
MUL (indexed)

Multiply (indexed).

Multiply all integer elements within each 128-bit segment of the first source vector by the specified element in the corresponding second source vector segment. The results are placed in the corresponding elements of the destination vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element. This instruction is unpredicated.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

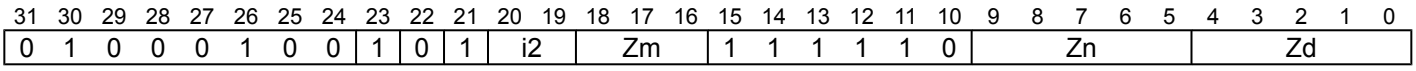


16-bit

```
MUL <Zd>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

32-bit

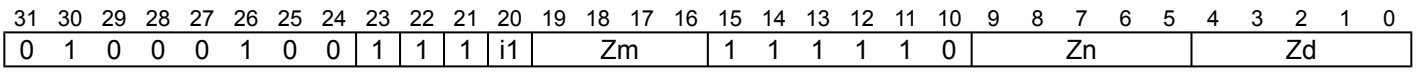


32-bit

```
MUL <Zd>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

64-bit



64-bit

```
MUL <Zd>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, s, esize]);
    integer res = element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

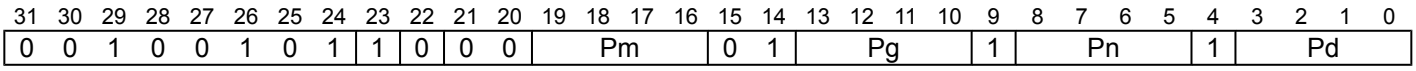
NAND, NANDS

Bitwise NAND predicates.

Bitwise NAND active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

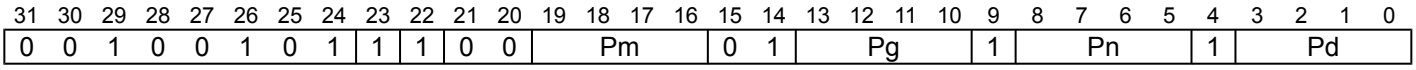


Not setting the condition flags

```
NAND <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
NANDS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = NOT(element1 AND element2);
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

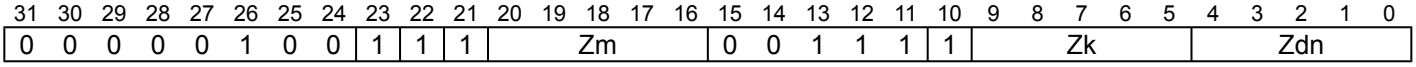
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

NBSL

Bitwise inverted select.

Selects bits from the first source vector where the corresponding bit in the third source vector is '1', and from the second source vector where the corresponding bit in the third source vector is '0'. The inverted result is placed destructively in the destination and first source vector. This instruction is unpredicated.



SVE2

```
NBSL <Zdn>.D, <Zdn>.D, <Zm>.D, <Zk>.D
```

```
if !HaveSVE2() then UNDEFINED;
integer m = UInt(Zm);
integer k = UInt(Zk);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.
<Zk>	Is the name of the third source scalable vector register, encoded in the "Zk" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[k];

Z[dn] = NOT((operand1 AND operand3) OR (operand2 AND NOT(operand3)));
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

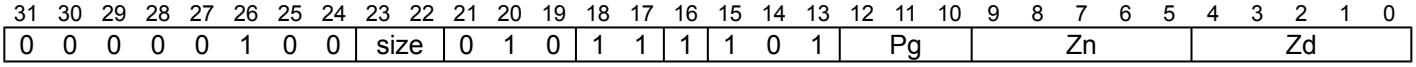
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

NEG

Negate (predicated).

Negate the signed integer value in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
NEG <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    integer element = SInt(Elem[operand, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        element = -element;
        Elem[result, e, esize] = element<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

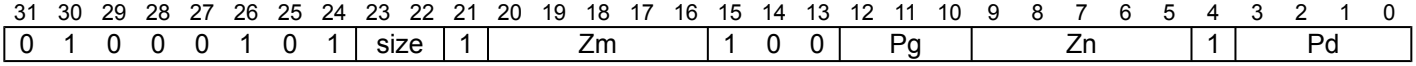
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

NMATCH

Detect no matching elements, setting the condition flags.

This instruction compares each active 8-bit or 16-bit character in the first source vector with all of the characters in the corresponding 128-bit segment of the second source vector. Where the first source element detects no matching characters in the second segment it places true in the corresponding element of the destination predicate, otherwise false. Inactive elements in the destination predicate register are set to zero. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
NMATCH <Pd>.<T>, <Pg>/Z, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '1x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer d = UInt(Pd);
integer n = UInt(Zn);
integer m = UInt(Zm);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	B
1	H

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(PL) result;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer segmentbase = e - e MOD eltspersegment;
        ElemP[result, e, esize] = '1';
        bits(esize) element1 = Elem[operand1, e, esize];
        for i = segmentbase to segmentbase + eltspersegment - 1
            bits(esize) element2 = Elem[operand2, i, esize];
            if element1 == element2 then
                ElemP[result, e, esize] = '0';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

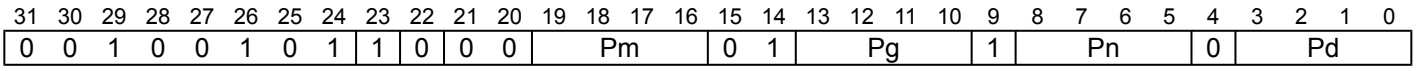
NOR, NORS

Bitwise NOR predicates.

Bitwise NOR active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

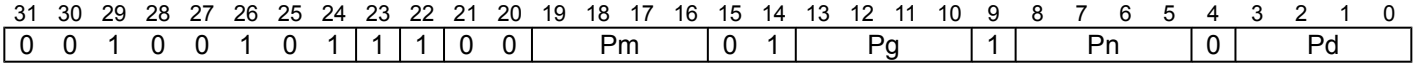


Not setting the condition flags

```
NOR <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
NORS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = NOT(element1 OR element2);
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

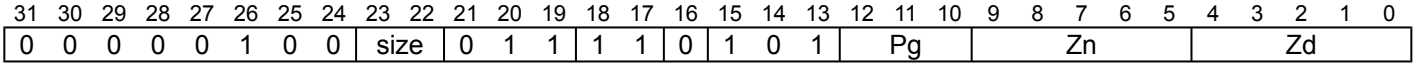
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

NOT (vector)

Bitwise invert vector (predicated).

Bitwise invert each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
NOT <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = NOT element;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

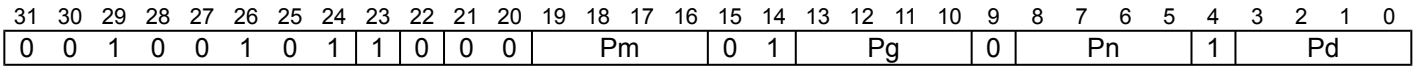
ORN, ORNS (predicates)

Bitwise inclusive OR inverted predicate.

Bitwise inclusive OR inverted active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

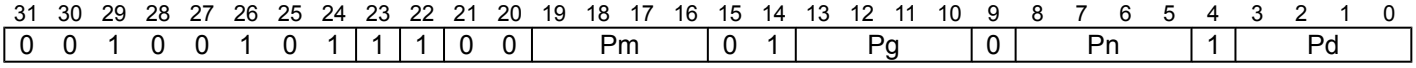


Not setting the condition flags

```
ORN <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
ORNS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = element1 OR (NOT element2);
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ORR, ORRS (predicates)

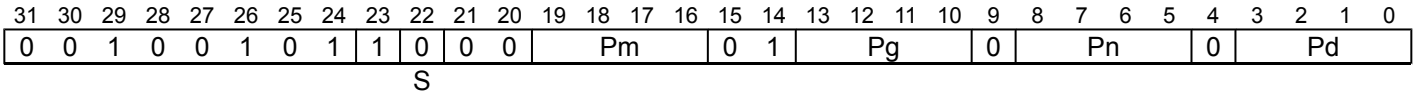
Bitwise inclusive OR predicate.

Bitwise inclusive OR active elements of the second source predicate with corresponding elements of the first source predicate and place the results in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

This instruction is used by the aliases MOVS ~~(unpredicated)~~, and MOV ~~(predicate, unpredicated)~~.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

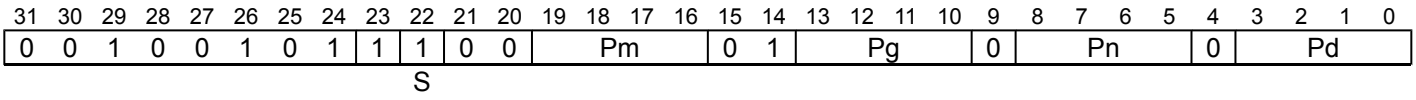


Not setting the condition flags

```
ORR <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
ORRS <Pd>.B, <Pg>/Z, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Alias Conditions

Alias	Is preferred when
MOVS ~~(unpredicated)~~	`S == '1' && Pn == Pm && Pm == Pg`
MOV ~~(predicate, unpredicated)~~	`S == '0' && Pn == Pm && Pm == Pg`

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = element1 OR element2;
    else
        ElemP[result, e, esize] = '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

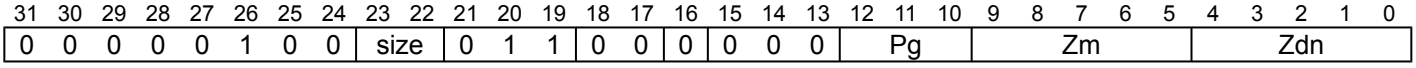
(old) htmldiff from- (new)

(old) htmldiff from- (new)

ORR (vectors, predicated)

Bitwise inclusive OR vectors (predicated).

Bitwise inclusive OR active elements of the second source vector with corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
ORR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1 OR element2;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

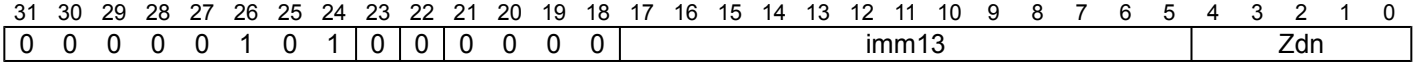
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

ORR (immediate)

Bitwise inclusive OR with immediate (unpredicated).

Bitwise inclusive OR an immediate with each 64-bit element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is a 64-bit value consisting of a single run of ones or zeros repeating every 2, 4, 8, 16, 32 or 64 bits. This instruction is unpredicated.

This instruction is used by the pseudo-instruction ORN (immediate).



SVE

```
ORR <Zdn>.<T>, <Zdn>.<T>, #<const>
```

```
if !HaveSVE() then UNDEFINED;
integer dn = UInt(Zdn);
bits(64) imm;
(imm, -) = DecodeBitMasks(imm13<12>, imm13<5:0>, imm13<11:6>, TRUE);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “imm13<12>:imm13<5:0>”:

imm13<12>	imm13<5:0>	<T>
0	0xxxxx	S
0	10xxxx	H
0	110xxx	B
0	1110xx	B
0	11110x	B
0	111110	RESERVED
0	111111	RESERVED
1	xxxxxx	D

<const> Is a 64, 32, 16 or 8-bit bitmask consisting of replicated 2, 4, 8, 16, 32 or 64 bit fields, each field containing a rotated run of non-zero bits, encoded in the "imm13" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV 64;
bits(VL) operand = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(64) element1 = Elem[operand, e, 64];
    Elem[result, e, 64] = element1 OR imm;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

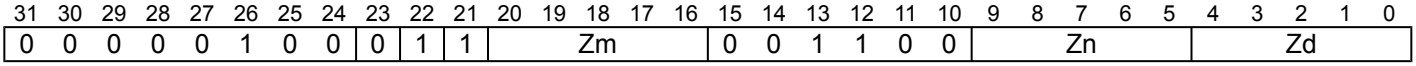
(old) htmldiff from- (new)

ORR (vectors, unpredicated)

Bitwise inclusive OR vectors (unpredicated).

Bitwise inclusive OR all elements of the second source vector with corresponding elements of the first source vector and place the first in the corresponding elements of the destination vector. This instruction is unpredicated.

This instruction is used by the alias MOV (vector, unpredicated).



SVE

```
ORR <Zd>.D, <Zn>.D, <Zm>.D
```

```
if !HaveSVE() then UNDEFINED;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Alias Conditions

Alias	Is preferred when
MOV (vector, unpredicated)	`Zn == Zm`

Operation

```
CheckSVEEnabled();
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];

Z[d] = operand1 OR operand2;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

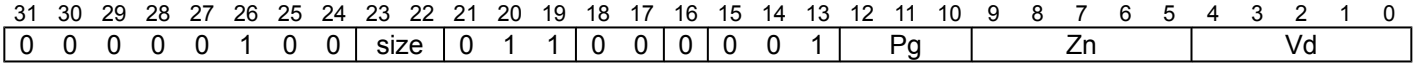
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

ORV

Bitwise inclusive OR reduction to scalar.

Bitwise inclusive OR horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as zero.



SVE

```
ORV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(esize) result = Zeros(esize);

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        result = result OR Elem[operand, e, esize];

V[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

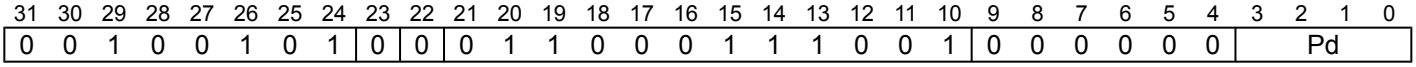
(old) htmldiff from- (new)

(old) htmldiff from- (new)

PFALSE

Set all predicate elements to false.

Set all elements in the destination predicate to false.



SVE

```
PFALSE <Pd>.B
```

```
if !HaveSVE() then UNDEFINED;
integer d = UInt(Pd);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

Operation

```
CheckSVEEnabled();
P[d] = Zeros(PL);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

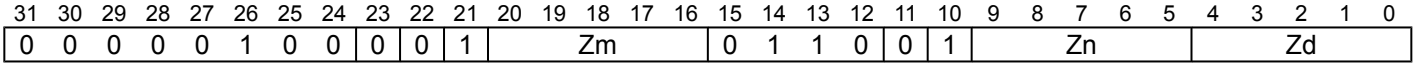
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

PMUL

Polynomial multiply vectors (unpredicated).

Polynomial multiply over [0, 1] all elements of the second source vector to corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
PMUL <Zd>.B, <Zn>.B, <Zm>.B
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    Elem[result, e, esize] = PolynomialMult(element1, element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

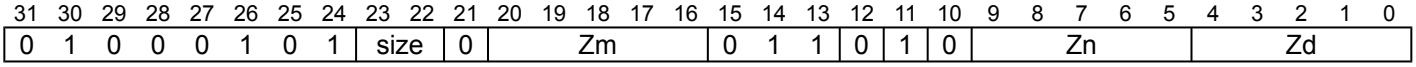
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

PMULLB

Polynomial multiply long (bottom).

Polynomial multiply over [0, 1] the corresponding even-numbered elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
PMULLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' && !HaveSVE2PMULL128() then UNDEFINED;
case size of
    when '00' esize = 128;
    when '01' esize = 16;
    when '10' UNDEFINED;
    when '11' esize = 64;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	Q
01	H
10	RESERVED
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	D
01	B
10	RESERVED
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize DIV 2) element1 = Elem[operand1, 2*e + 0, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, 2*e + 0, esize DIV 2];
    Elem[result, e, esize] = PolynomialMult(element1, element2);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

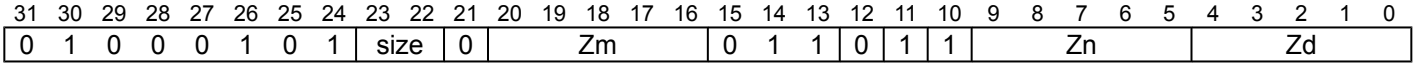
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

PMULLT

Polynomial multiply long (top).

Polynomial multiply over [0, 1] the corresponding odd-numbered elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
PMULLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' && !HaveSVE2PMULL128() then UNDEFINED;
case size of
    when '00' esize = 128;
    when '01' esize = 16;
    when '10' UNDEFINED;
    when '11' esize = 64;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	Q
01	H
10	RESERVED
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	D
01	B
10	RESERVED
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize DIV 2) element1 = Elem[operand1, 2*e + 1, esize DIV 2];
    bits(esize DIV 2) element2 = Elem[operand2, 2*e + 1, esize DIV 2];
    Elem[result, e, esize] = PolynomialMult(element1, element2);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

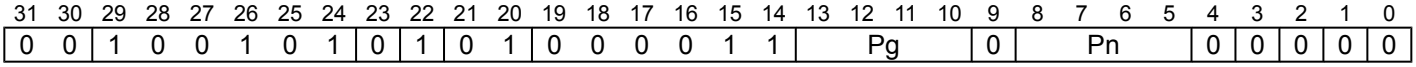
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

PTEST

Set condition flags for predicate.

Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate source register, and the V flag to zero.



SVE

```
PTEST <Pg>, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
```

Assembler Symbols

<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the source scalable predicate register, encoded in the "Pn" field.

Operation

```
CheckSVEEnabled();
bits(PL) mask = P[g];
bits(PL) result = P[n];

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

PTRUE, PTRUES

Initialise predicate from named constraint.

Set elements of the destination predicate to true if the element number satisfies the named predicate constraint, or to false otherwise. If the constraint specifies more elements than are available at the current vector length then all elements of the destination predicate are set to false.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.
Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		0	1	1	0	0	0	1	1	1	0	0	0	pattern					0	Pd			

Not setting the condition flags

```
PTRUE <Pd>.<T>{, <pattern>}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer d = UInt(Pd);
boolean setflags = FALSE;
bits(5) pat = pattern;
```

Setting the condition flags

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		0	1	1	0	0	1	1	1	1	0	0	0	pattern					0	Pd			

Setting the condition flags

```
PTRUES <Pd>.<T>{, <pattern>}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer d = UInt(Pd);
boolean setflags = TRUE;
bits(5) pat = pattern;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(PL) result;

for e = 0 to elements-1
    ElemP[result, e, esize] = if e < count then '1' else '0';

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(result, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

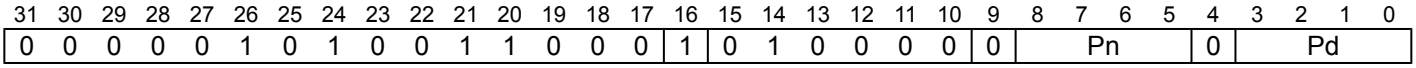
PUNPKHI, PUNPKLO

Unpack and widen half of predicate.

Unpack elements from the lowest or highest half of the source predicate and place in elements of twice their size within the destination predicate. This instruction is unpredicated.

It has encodings from 2 classes: High half and Low half

High half

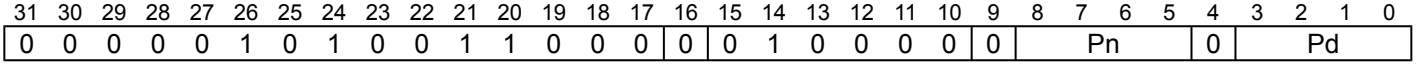


High half

```
PUNPKHI <Pd>.H, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer n = UInt(Pn);
integer d = UInt(Pd);
boolean hi = TRUE;
```

Low half



Low half

```
PUNPKLO <Pd>.H, <Pn>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer n = UInt(Pn);
integer d = UInt(Pd);
boolean hi = FALSE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pn>	Is the name of the source scalable predicate register, encoded in the "Pn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) operand = P[n];
bits(PL) result;

for e = 0 to elements-1
    ElemP[result, e, esize] = ElemP[operand, if hi then e + elements else e, esize DIV 2];

P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

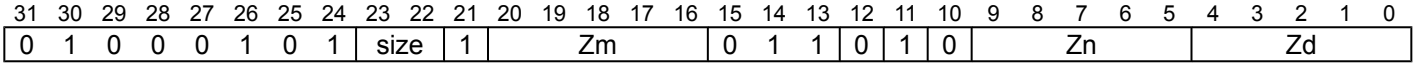
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

RADDHNB

Rounding add narrow high part (bottom).

Add each vector element of the first source vector to the corresponding vector element of the second source vector, and place the most significant rounded half of the result in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. This instruction is unpredicated.



SVE2

```
RADDHNB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer halfesize = esize DIV 2;
integer round_const = 1 << (halfesize - 1);

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = ((element1 + element2) + round_const) >> halfesize;
    Elem[result, 2*e + 0, halfesize] = res<halfesize-1:0>;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

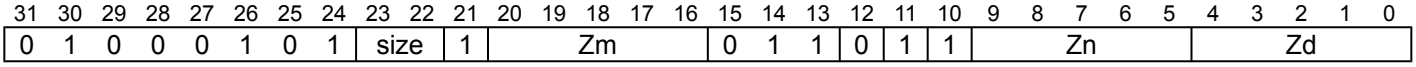
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

RADDHNT

Rounding add narrow high part (top).

Add each vector element of the first source vector to the corresponding vector element of the second source vector, and place the most significant rounded half of the result in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. This instruction is unpredicated.



SVE2

```
RADDHNT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;
integer round_const = 1 << (halfesize - 1);

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = ((element1 + element2) + round_const) >> halfesize;
    Elem[result, 2*e + 1, halfesize] = res<halfesize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

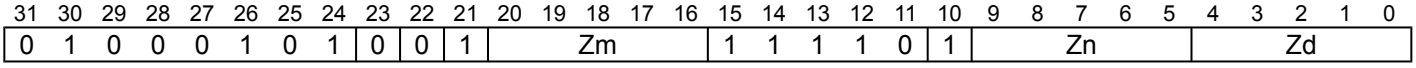
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

RAX1

Bitwise rotate left by 1 and exclusive OR.

Rotate each 64-bit element of the second source vector left by 1 and exclusive OR with the corresponding elements of the first source vector. The results are placed in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
RAX1 <Zd>.D, <Zn>.D, <Zm>.D
```

```
if !HaveSVE2SHA3() then UNDEFINED;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV 64;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(64) element1 = Elem[operand1, e, 64];
    bits(64) element2 = Elem[operand2, e, 64];
    Elem[result, e, 64] = element1 EOR ROL(element2, 1);
Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

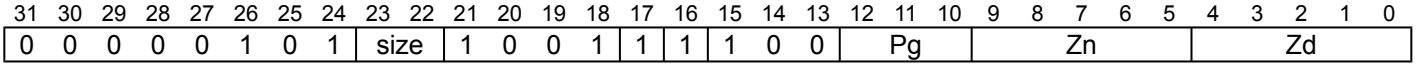
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

RBIT

Reverse bits (predicated).

Reverse bits in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
RBIT <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = BitReverse(element);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

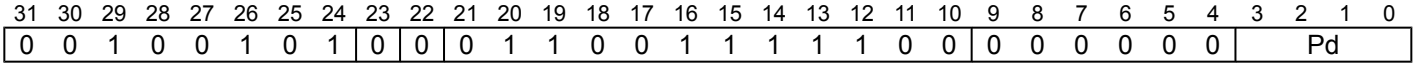
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

RDFFR (unpredicated)

Read the first-fault register.

Read the first-fault register (FFR) and place in the destination predicate without predication.



SVE

```
RDFFR <Pd>.B
```

```
if !HaveSVE() then UNDEFINED;
integer d = UInt(Pd);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

Operation

```
CheckSVEEnabled();
bits(PL) ffr = FFR[];
P[d] = ffr;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

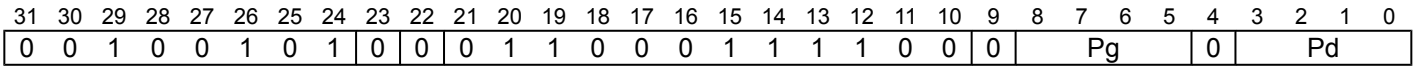
RDFFR, RDFFRS (predicated)

Return predicate of succesfully loaded elements.

Read the first-fault register (FFR) and place active elements in the corresponding elements of the destination predicate. Inactive elements in the destination predicate register are set to zero. Optionally sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.

It has encodings from 2 classes: Not setting the condition flags and Setting the condition flags

Not setting the condition flags

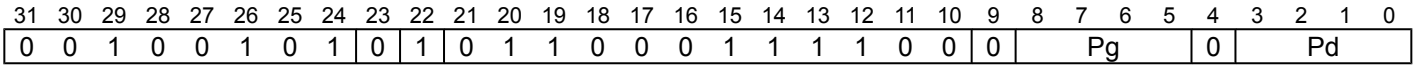


Not setting the condition flags

```
RDFFR <Pd>.B, <Pg>/Z
```

```
if !HaveSVE() then UNDEFINED;
integer g = UInt(Pg);
integer d = UInt(Pd);
boolean setflags = FALSE;
```

Setting the condition flags



Setting the condition flags

```
RDFFRS <Pd>.B, <Pg>/Z
```

```
if !HaveSVE() then UNDEFINED;
integer g = UInt(Pg);
integer d = UInt(Pd);
boolean setflags = TRUE;
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.

Operation

```
CheckSVEEnabled();
bits(PL) mask = P[g];
bits(PL) ffr = FFR[];
bits(PL) result = ffr AND mask;

if setflags then
    PSTATE.<N,Z,C,V> = PredTest(mask, result, 8);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

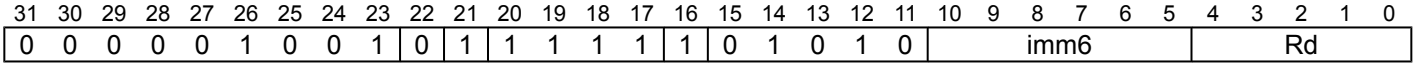
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

RDVL

Read multiple of vector register size to scalar register.

Multiply the current vector register size in bytes by an immediate in the range -32 to 31 and place the result in the 64-bit destination general-purpose register.



SVE

```
RDVL <Xd>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer d = UInt(Rd);
integer imm = SInt(imm6);
```

Assembler Symbols

<Xd>	Is the 64-bit name of the destination general-purpose register, encoded in the "Rd" field.
<imm>	Is the signed immediate operand, in the range -32 to 31, encoded in the "imm6" field.

Operation

```
CheckSVEEnabled();
integer len = imm * (VL DIV 8);
X[d] = len<63:0>;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

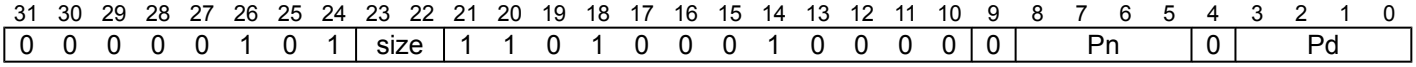
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

REV (predicate)

Reverse all elements in a predicate.

Reverse the order of all elements in the source predicate and place in the destination predicate. This instruction is unpredicated.



SVE

```
REV <Pd>.<T>, <Pn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer d = UInt(Pd);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pn> Is the name of the source scalable predicate register, encoded in the "Pn" field.

Operation

```
CheckSVEEnabled();
bits(PL) operand = P[n];
bits(PL) result = Reverse(operand, esize DIV 8);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

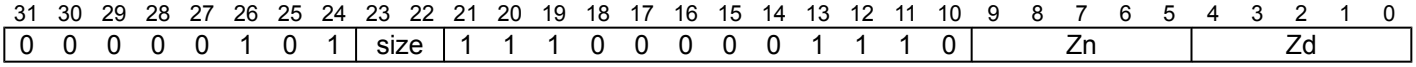
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

REV (vector)

Reverse all elements in a vector (unpredicated).

Reverse the order of all elements in the source vector and place in the destination vector. This instruction is unpredicated.



SVE

```
REV <Zd>.<T>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
bits(VL) operand = Z[n];
bits(VL) result = Reverse(operand, esize);
Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

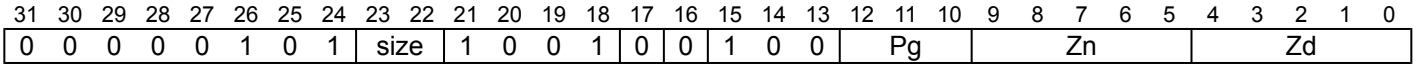
REVB, REVH, REVW

Reverse bytes / halfwords / words within elements (predicated).

Reverse the order of 8-bit bytes, 16-bit halfwords or 32-bit words within each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.

It has encodings from 3 classes: Byte , Halfword and Word

Byte

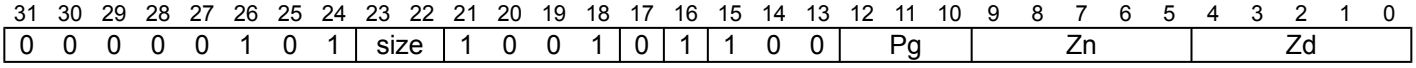


Byte

```
REVB <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer swsize = 8;
```

Halfword

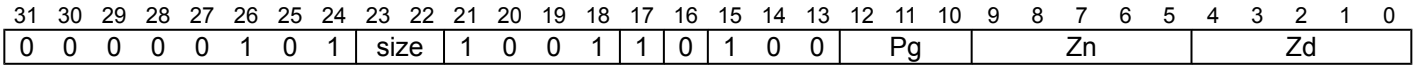


Halfword

```
REVH <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size != '1x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer swsize = 16;
```

Word



Word

```
REVW <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
if size != '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer swsize = 32;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> For the byte variant: is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

For the halfword variant: is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        bits(esize) element = Elem[operand, e, esize];
        Elem[result, e, esize] = Reverse(element, swsize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

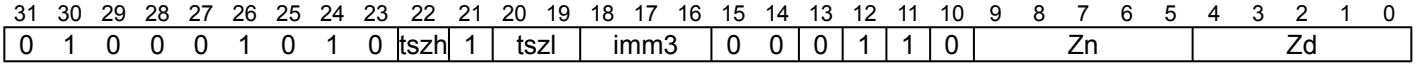
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

RSHRNB

Rounding shift right narrow by immediate (bottom).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the rounded results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
RSHRNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (UInt(element) + round_const) >> shift;
    Elem[result, 2*e + 0, esize] = res<esize-1:0>;
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

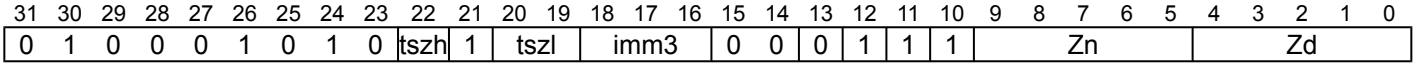
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

RSHRNT

Rounding shift right narrow by immediate (top).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the rounded results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
RSHRNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (UInt(element) + round_const) >> shift;
    Elem[result, 2*e + 1, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

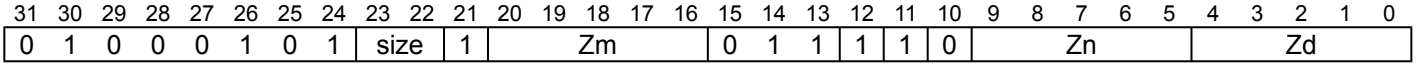
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

RSUBHNB

Rounding subtract narrow high part (bottom).

Subtract each vector element of the second source vector from the corresponding vector element in the first source vector, and place the most significant rounded half of the result in the even-numbered half-width destination elements, while setting the odd-numbered half-width destination elements to zero. This instruction is unpredicated.



SVE2

```
RSUBHNB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer halfesize = esize DIV 2;
integer round_const = 1 << (halfesize - 1);

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = ((element1 - element2) + round_const) >> halfesize;
    Elem[result, 2*e + 0, halfesize] = res<halfesize-1:0>;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

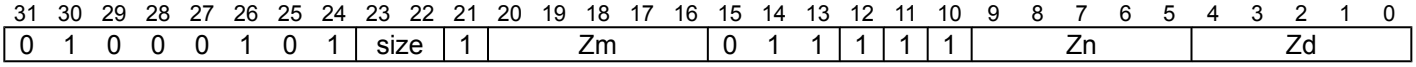
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

RSUBHNT

Rounding subtract narrow high part (top).

Subtract each vector element of the second source vector from the corresponding vector element in the first source vector, and place the most significant rounded half of the result in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. This instruction is unpredicated.



SVE2

```
RSUBHNT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;
integer round_const = 1 << (halfesize - 1);

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = ((element1 - element2) + round_const) >> halfesize;
    Elem[result, 2*e + 1, halfesize] = res<halfesize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

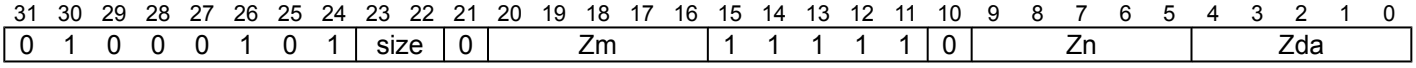
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SABA

Signed absolute difference and accumulate.

Compute the absolute difference between signed integer values in elements of the second source vector and corresponding elements of the first source vector, and add the difference to the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
SABA <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    integer element3 = Int(Elem[result, e, esize], unsigned);
    integer res = element3 + Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

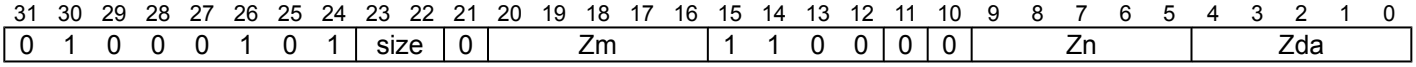
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SABALB

Signed absolute difference and accumulate long (bottom).

Compute the absolute difference between even-numbered signed integer values in elements of the second source vector and corresponding elements of the first source vector, and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
SABALB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer res = element3 + Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

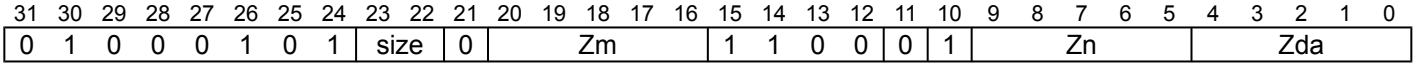
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SABALT

Signed absolute difference and accumulate long (top).

Compute the absolute difference between odd-numbered signed elements of the second source vector and corresponding elements of the first source vector, and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
SABALT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer res = element3 + Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

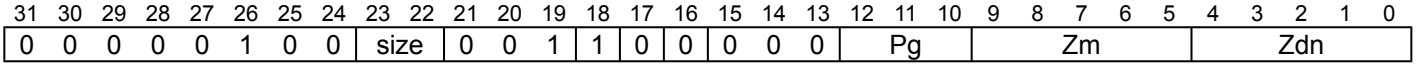
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SABD

Signed absolute difference (predicated).

Compute the absolute difference between signed integer values in active elements of the second source vector and corresponding elements of the first source vector and destructively place the difference in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SABD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer absdiff = Abs(element1 - element2);
        Elem[result, e, esize] = absdiff<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

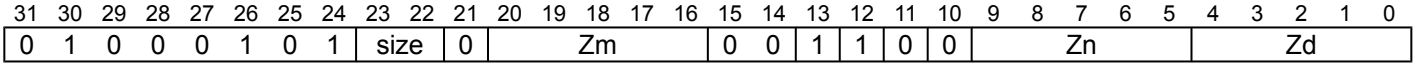
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SABDLB

Signed absolute difference long (bottom).

Compute the absolute difference between even-numbered signed integer values in elements of the second source vector and corresponding elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SABDLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer res = Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

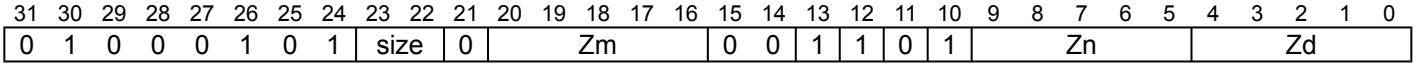
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SABDLT

Signed absolute difference long (top).

Compute the absolute difference between odd-numbered signed integer values in elements of the second source vector and corresponding elements of the first source vector, and place the results in overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SABDLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer res = Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

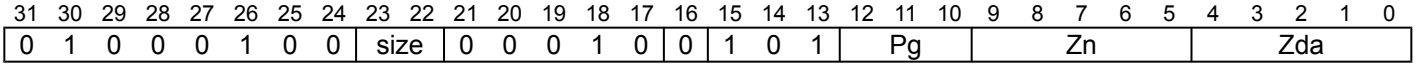
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SADALP

Signed add and accumulate long pairwise.

Add pairs of adjacent signed integer values and accumulate the results into the overlapping double-width elements of the destination vector.



SVE2

```
SADALP <Zda>.<T>, <Pg>/M, <Zn>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the second source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand_acc = Z[da];
bits(VL) operand_src = Z[n];
bits(VL) result;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand_acc, e, esize];
    else
        integer element1 = SInt(Elem[operand_src, 2*e + 0, esize DIV 2]);
        integer element2 = SInt(Elem[operand_src, 2*e + 1, esize DIV 2]);
        integer element3 = SInt(Elem[operand_acc, e, esize]);

        Elem[result, e, esize] = (element1 + element2 + element3)<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

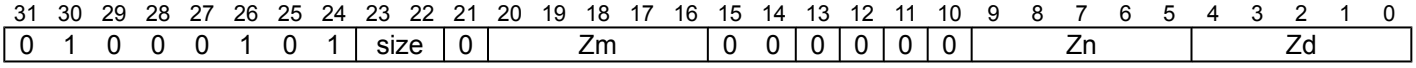
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SADDLB

Signed add long (bottom).

Add the corresponding even-numbered signed elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SADDLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 0;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 + element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

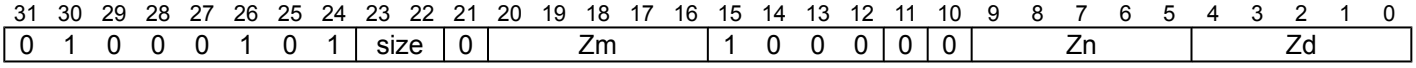
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SADDLBT

Signed add long (bottom + top).

Add the even-numbered signed elements of the first source vector to the odd-numbered signed elements of the second source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SADDLBT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 + element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

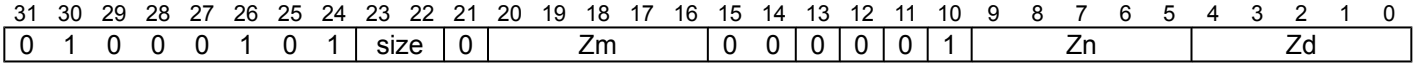
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SADDLT

Signed add long (top).

Add the corresponding odd-numbered signed elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SADDLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 1;
integer sel2 = 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 + element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

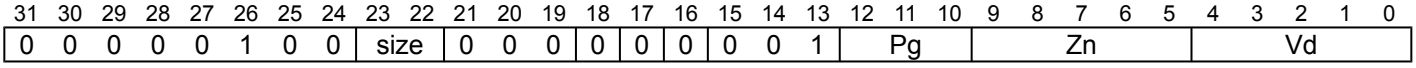
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SADDV

Signed add reduction to scalar.

Signed add horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Narrow elements are first sign-extended to 64 bits. Inactive elements in the source vector are treated as zero.



SVE

```
SADDV <Dd>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
```

Assembler Symbols

<Dd> Is the 64-bit name of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer sum = 0;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer element = SInt(Elem[operand, e, esize]);
        sum = sum + element;

V[d] = sum<63:0>;
```

Operational information

If PSTATE.DIT is 1:

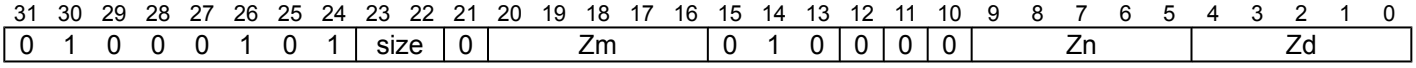
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

SADDWB

Signed add wide (bottom).

Add the even-numbered signed elements of the second source vector to the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SADDWB <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    Elem[result, e, esize] = (element1 + element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

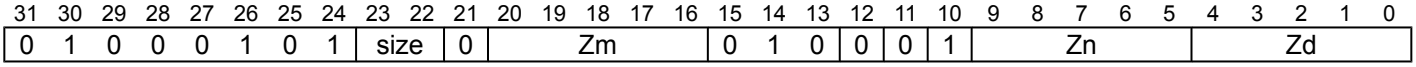
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SADDWT

Signed add wide (top).

Add the odd-numbered signed elements of the second source vector to the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SADDWT <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    Elem[result, e, esize] = (element1 + element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

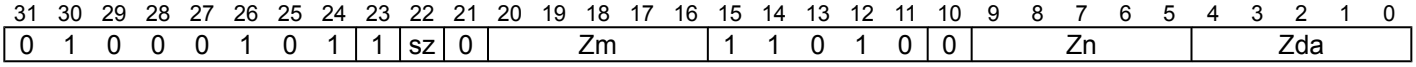
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SBCLB

Subtract with carry long (bottom).

Subtract the even-numbered elements of the first source vector and the inverted 1-bit carry from the least-significant bit of the odd-numbered elements of the second source vector from the even-numbered elements of the destination and accumulator vector. The 1-bit carry output is placed in the corresponding odd-numbered element of the destination vector.



SVE2

```
SBCLB <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “sz”:

sz	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(VL) operand = Z[n];
bits(VL) carries = Z[m];
bits(VL) result = Z[da];

for p = 0 to pairs-1
    bits(esize) element1 = Elem[result, 2*p + 0, esize];
    bits(esize) element2 = Elem[operand, 2*p + 0, esize];
    bit carry_in = Elem[carries, 2*p + 1, esize]<0>;

    (res, nzcv) = AddWithCarry(element1, NOT(element2), carry_in);
    carry_out = nzcv<1>;

    Elem[result, 2*p + 0, esize] = res;
    Elem[result, 2*p + 1, esize] = ZeroExtend(carry_out);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

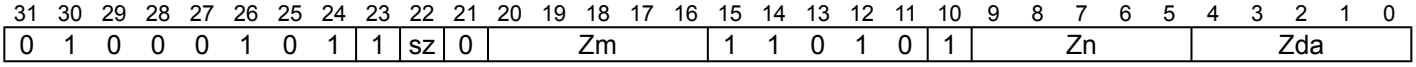
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SBCLT

Subtract with carry long (top).

Subtract the odd-numbered elements of the first source vector and the inverted 1-bit carry from the least-significant bit of the odd-numbered elements of the second source vector from the even-numbered elements of the destination and accumulator vector. The 1-bit carry output is placed in the corresponding odd-numbered element of the destination vector.



SVE2

```
SBCLT <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32 << UInt(sz);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “sz”:

sz	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(VL) operand = Z[n];
bits(VL) carries = Z[m];
bits(VL) result = Z[da];

for p = 0 to pairs-1
    bits(esize) element1 = Elem[result, 2*p + 0, esize];
    bits(esize) element2 = Elem[operand, 2*p + 1, esize];
    bit carry_in = Elem[carries, 2*p + 1, esize]<0>;

    (res, nzcv) = AddWithCarry(element1, NOT(element2), carry_in);
    carry_out = nzcv<1>;

    Elem[result, 2*p + 0, esize] = res;
    Elem[result, 2*p + 1, esize] = ZeroExtend(carry_out);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

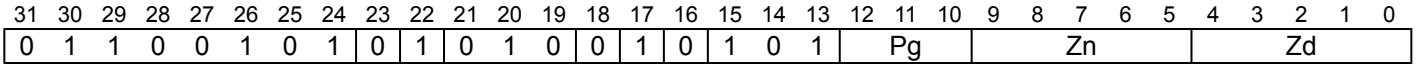
SCVTF

Signed integer convert to floating-point (predicated).

Convert to floating-point from the signed integer in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
If the input and result types have a different size the smaller type is held unpacked in the least significant bits of elements of the larger size. When the input is the smaller type the upper bits of each source element are ignored. When the result is the smaller type the upper bits of each destination element are set to zero.

It has encodings from 7 classes: 16-bit to half-precision , 32-bit to half-precision , 32-bit to single-precision , 32-bit to double-precision , 64-bit to half-precision , 64-bit to single-precision and 64-bit to double-precision

16-bit to half-precision

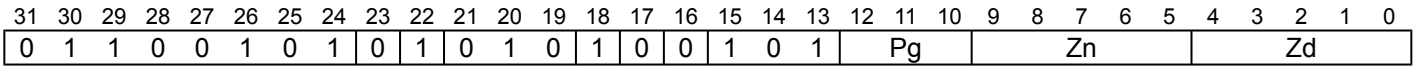


16-bit to half-precision

```
SCVTF <Zd>.H, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 16;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

32-bit to half-precision

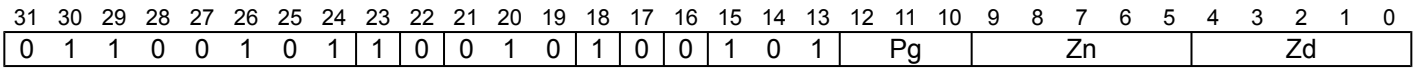


32-bit to half-precision

```
SCVTF <Zd>.H, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 16;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

32-bit to single-precision

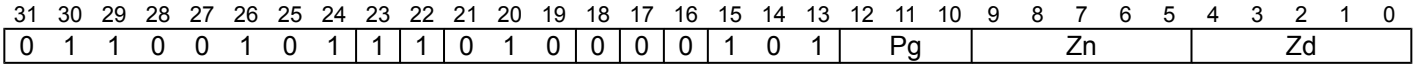


32-bit to single-precision

```
SCVTF <Zd>.S, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 32;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

32-bit to double-precision

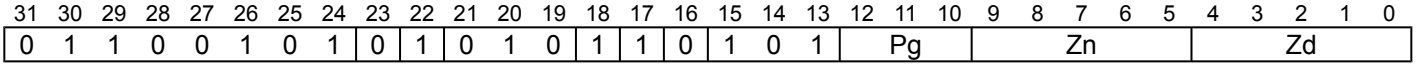


32-bit to double-precision

```
SCVTF <Zd>.D, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 64;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

64-bit to half-precision

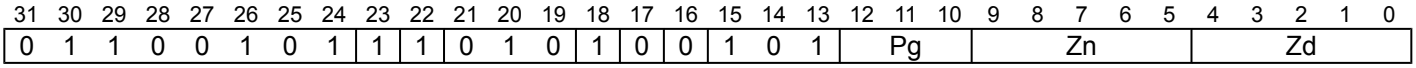


64-bit to half-precision

```
SCVTF <Zd>.H, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 16;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

64-bit to single-precision

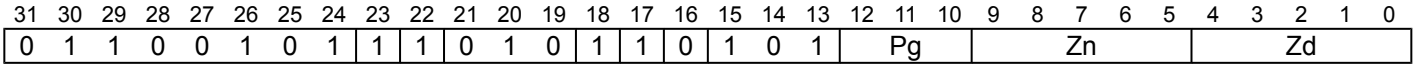


64-bit to single-precision

```
SCVTF <Zd>.S, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 32;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

64-bit to double-precision



64-bit to double-precision

```
SCVTF <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 64;
boolean unsigned = FALSE;
FPRounding rounding = FPRoundingMode(FPCR);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        bits(d_esize) fpval = FixedToFP(element<s_esize-1:0>, 0, unsigned, FPCR, rounding);
        Elem[result, e, esize] = ZeroExtend(fpval);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

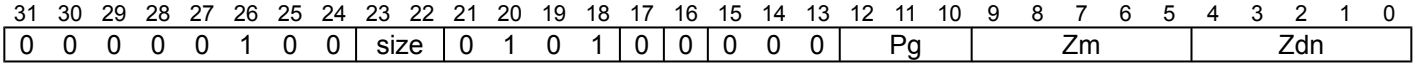
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SDIV

Signed divide (predicated).

Signed divide active elements of the first source vector by corresponding elements of the second source vector and destructively place the quotient in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SDIV <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer quotient;
        if element2 == 0 then
            quotient = 0;
        else
            quotient = RoundTowardsZero(Real(element1) / Real(element2));
        Elem[result, e, esize] = quotient<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

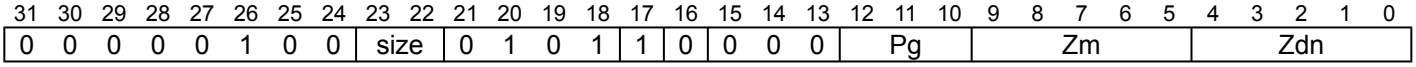
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SDIVR

Signed reversed divide (predicated).

Signed reversed divide active elements of the second source vector by corresponding elements of the first source vector and destructively place the quotient in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SDIVR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer quotient;
        if element1 == 0 then
            quotient = 0;
        else
            quotient = RoundTowardsZero(Real(element2) / Real(element1));
        Elem[result, e, esize] = quotient<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

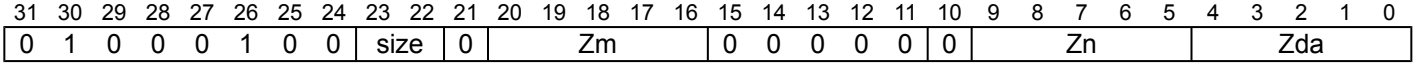
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SDOT (vectors)

Signed dot product.

The signed integer partial dot product instruction delimits the source vectors into quadtuplets of four 8-bit or 16-bit signed integer elements. Within each quadtuplet the elements in the first source vector are multiplied by the corresponding elements in the second source vector and the resulting widened products are summed and added to the 32-bit or 64-bit element of the accumulator and destination vector which aligns with the quadtuplet in the first source vector.



SVE

```
SDOT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size<0>”:

size<0>	<Tb>
0	B
1	H

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) res = Elem[operand3, e, esize];
    for i = 0 to 3
        integer element1 = SInt(Elem[operand1, 4 * e + i, esize DIV 4]);
        integer element2 = SInt(Elem[operand2, 4 * e + i, esize DIV 4]);
        res = res + element1 * element2;
    Elem[result, e, esize] = res;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SDOT (indexed)

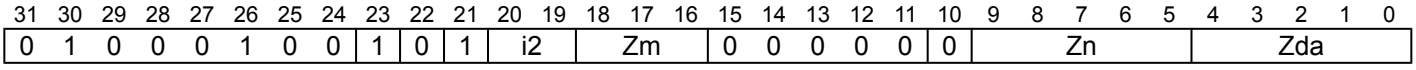
Signed dot product by indexed quadtuplet.

The indexed signed integer partial dot product instruction delimits the source vectors into quadtuplets of four 8-bit or 16-bit signed integer elements. Within each quadtuplet of each 128-bit vector segment the elements in the first source vector are multiplied by the corresponding elements in the specified quadtuplet of the second source vector segment and the resulting widened products are summed and added to the 32-bit or 64-bit element of the accumulator and destination vector which aligns with the quadtuplet in the first source vector.

The quadtuplets within the second source vector are specified using an immediate index which selects the same quadtuplet position within each 128-bit vector segment. The index range is from 0 to one less than the number of quadtuplets per 128-bit segment, encoded in 1 to 2 bits depending on the size of the quadtuplet.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

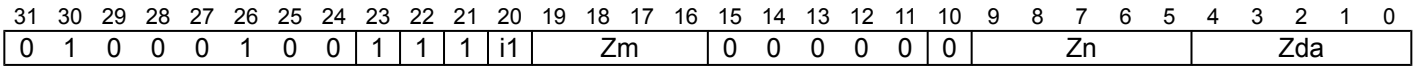


32-bit

```
SDOT <Zda>.S, <Zn>.B, <Zm>.B[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

64-bit



64-bit

```
SDOT <Zda>.D, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the immediate index of a quadtuplet of four 8-bit elements within each 128-bit vector segment, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the immediate index of a quadtuplet of four 16-bit elements within each 128-bit vector segment, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    bits(esize) res = Elem[operand3, e, esize];
    for i = 0 to 3
        integer element1 = SInt(Elem[operand1, 4 * e + i, esize DIV 4]);
        integer element2 = SInt(Elem[operand2, 4 * s + i, esize DIV 4]);
        res = res + element1 * element2;
    Elem[result, e, esize] = res;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

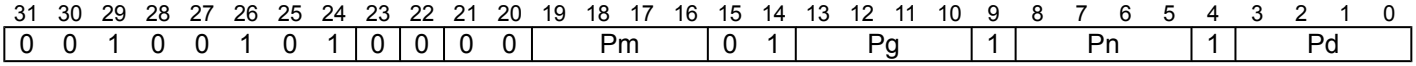
(old) htmldiff from- (new)

SEL (predicates)

Conditionally select elements from two predicates.

Read active elements from the first source predicate and inactive elements from the second source predicate and place in the corresponding elements of the destination predicate. Does not set the condition flags.

This instruction is used by the alias MOV (predicate, predicated, merging).



SVE

```
SEL <Pd>.B, <Pg>, <Pn>.B, <Pm>.B
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer g = UInt(Pg);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
```

Assembler Symbols

<Pd>	Is the name of the destination scalable predicate register, encoded in the "Pd" field.
<Pg>	Is the name of the governing scalable predicate register, encoded in the "Pg" field.
<Pn>	Is the name of the first source scalable predicate register, encoded in the "Pn" field.
<Pm>	Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Alias Conditions

Alias	Is preferred when
MOV (predicate, predicated, merging)	`Pd == Pm`

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for e = 0 to elements-1
    bit element1 = ElemP[operand1, e, esize];
    bit element2 = ElemP[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        ElemP[result, e, esize] = element1;
    else
        ElemP[result, e, esize] = element2;

P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

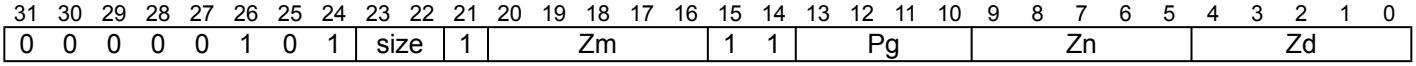
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SEL (vectors)

Conditionally select elements from two vectors.

Read active elements from the first source vector and inactive elements from the second source vector and place in the corresponding elements of the destination vector.

This instruction is used by the alias MOV (vector, predicated).



SVE

```
SEL <Zd>.<T>, <Pg>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Alias Conditions

Alias	Is preferred when
MOV (vector, predicated)	`Zd == Zm`

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1;
    else
        Elem[result, e, esize] = element2;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SETFFR

Initialise the first-fault register to all true.

Initialise the first-fault register (FFR) to all true prior to a sequence of first-fault or non-fault loads. This instruction is unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

SVE

```
SETFFR

if !HaveSVE() then UNDEFINED;
```

Operation

```
CheckSVEEnabled();
FFR[] = Ones(PL);
```

Operational information

If PSTATE.DIT is 1:

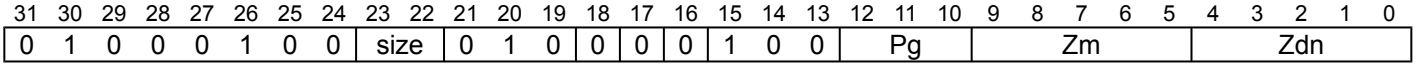
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SHADD

Signed halving addition.

Add active signed elements of the first source vector to corresponding signed elements of the second source vector, shift right one bit, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SHADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 + element2;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

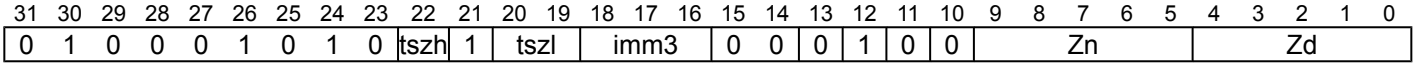
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SHRNB

Shift right narrow by immediate (bottom).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the truncated results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SHRNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = UInt(element) >> shift;
    Elem[result, 2*e + 0, esize] = res<esize-1:0>;
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

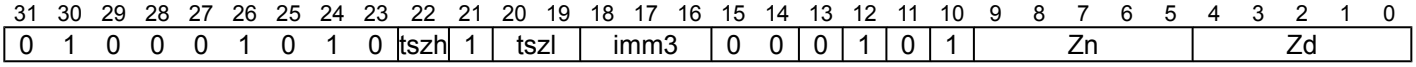
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SHRNT

Shift right narrow by immediate (top).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the truncated results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SHRNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = UInt(element) >> shift;
    Elem[result, 2*e + 1, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

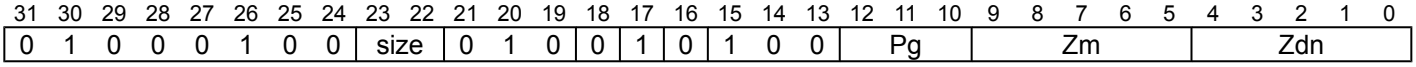
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SHSUB

Signed halving subtract.

Subtract active signed elements of the second source vector from corresponding signed elements of the first source vector, shift right one bit, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SHSUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 - element2;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

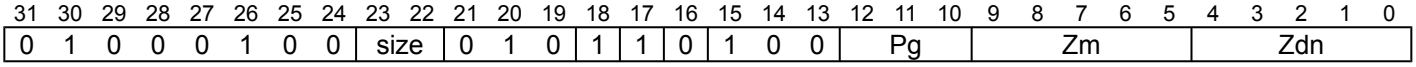
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SHSUBR

Signed halving subtract reversed vectors.

Subtract active signed elements of the first source vector from corresponding signed elements of the second source vector, shift right one bit, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SHSUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element2 - element1;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

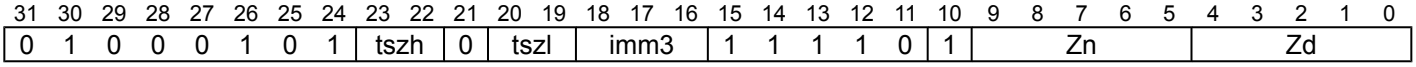
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SLI

Shift left and insert (immediate).

Shift each source vector element left by an immediate value, and insert the result into the corresponding vector element in the destination vector register, merging the shifted bits from each source element with existing bits in each destination vector element. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. This instruction is unpredicated.



SVE2

```
SLI <Zd>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element1 = Elem[result, e, esize];
    bits(esize) element2 = Elem[operand, e, esize];
    bits(esize) mask = LSL(Ones(esize), shift);
    bits(esize) shiftedval = LSL(element2, shift);
    Elem[result, e, esize] = (element1 AND (NOT mask)) OR shiftedval;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

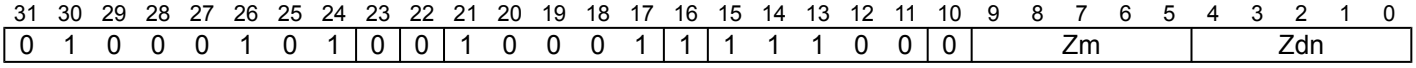
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SM4E

SM4 encryption and decryption.

The SM4E instruction reads 16 bytes of input data from each 128-bit segment of the first source vector, together with four iterations of 32-bit round keys from the corresponding 128-bit segments of the second source vector. Each block of data is encrypted by four rounds in accordance with the SM4 standard, and destructively placed in the corresponding segments of the first source vector. This instruction is unpredicated.



SVE2

```
SM4E <Zdn>.S, <Zdn>.S, <Zm>.S
```

```
if !HaveSVE2SM4() then UNDEFINED;
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn>	Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for s = 0 to segments-1
    bits(128) key = Elem[operand2, s, 128];
    bits(32) intval;
    bits(8) sboxout;
    bits(128) roundresult = Elem[operand1, s, 128];
    bits(32) roundkey;

    for index = 0 to 3
        roundkey = Elem[key, index, 32];
        intval = roundresult<127:96> EOR roundresult<95:64> EOR roundresult<63:32> EOR roundkey;

        for i = 0 to 3
            Elem[intval, i,8]  = Sbox(Elem[intval,i,8]);

        intval = intval EOR ROL(intval, 2) EOR ROL(intval,10) EOR ROL(intval,18) EOR ROL(intval, 24);
        intval = intval EOR roundresult<31:0>;

        roundresult<31:0> = roundresult<63:32>;
        roundresult<63:32> = roundresult<95:64>;
        roundresult<95:64> = roundresult<127:96>;
        roundresult<127:96> = intval;

    Elem[result, s, 128] = roundresult;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

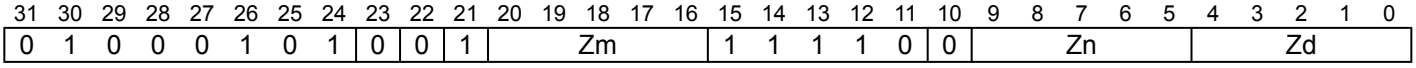
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SM4EKEY

SM4 key updates.

The SM4EKEY instruction reads four rounds of 32-bit input key values from each 128-bit segment of the first source vector, along with four rounds of 32-bit constants from the corresponding 128-bit segment of the second source vector. The four rounds of output key values are derived in accordance with the SM4 standard, and placed in the corresponding segments of the destination vector. This instruction is unpredicated.



SVE2

```
SM4EKEY <Zd>.S, <Zn>.S, <Zm>.S
```

```
if !HaveSVE2SM4() then UNDEFINED;
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer segments = VL DIV 128;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for s = 0 to segments-1
    bits(128) source = Elem[operand2, s, 128];
    bits(32) intval;
    bits(8) sboxout;
    bits(32) const;
    bits(128) roundresult = Elem[operand1, s, 128];

    for index = 0 to 3
        const = Elem[source, index, 32];
        intval = roundresult<127:96> EOR roundresult<95:64> EOR roundresult<63:32> EOR const;
        for i = 0 to 3
            Elem[intval, i, 8] = Sbox(Elem[intval, i, 8]);

        intval = intval EOR ROL(intval, 13) EOR ROL(intval, 23);
        intval = intval EOR roundresult<31:0>;

        roundresult<31:0> = roundresult<63:32>;
        roundresult<63:32> = roundresult<95:64>;
        roundresult<95:64> = roundresult<127:96>;
        roundresult<127:96> = intval;

    Elem[result, s, 128] = roundresult;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

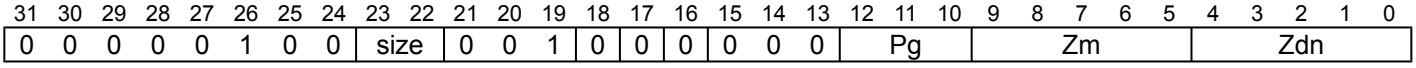
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMAX (vectors)

Signed maximum vectors (predicated).

Determine the signed maximum of active elements of the second source vector and corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SMAX <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer maximum = Max(element1, element2);
        Elem[result, e, esize] = maximum<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

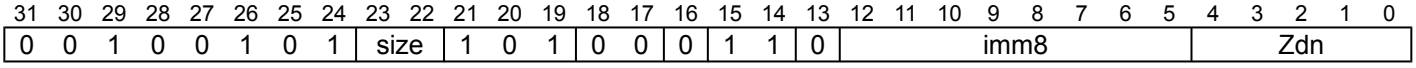
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SMAX (immediate)

Signed maximum with immediate (unpredicated).

Determine the signed maximum of an immediate and each element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is a signed 8-bit value in the range -128 to +127, inclusive. This instruction is unpredicated.



SVE

```
SMAX <Zdn>.<T>, <Zdn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
boolean unsigned = FALSE;
integer imm = Int(imm8, unsigned);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is the signed immediate operand, in the range -128 to 127, encoded in the "imm8" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    Elem[result, e, esize] = Max(element1, imm)<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

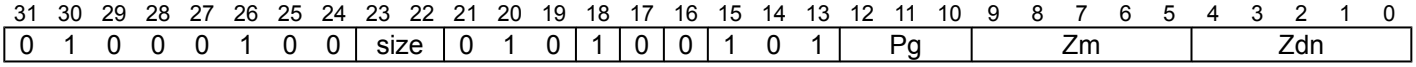
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SMAXP

Signed maximum pairwise.

Compute the maximum value of each pair of adjacent signed integer elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
SMAXP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer element1;
integer element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand1, e, esize];
    else
        if IsEven(e) then
            element1 = SInt(Elem[operand1, e + 0, esize]);
            element2 = SInt(Elem[operand1, e + 1, esize]);
        else
            element1 = SInt(Elem[operand2, e - 1, esize]);
            element2 = SInt(Elem[operand2, e + 0, esize]);
        integer res = Max(element1, element2);
        Elem[result, e, esize] = res<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

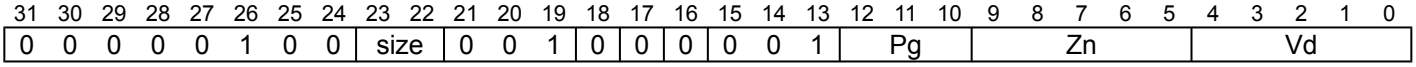
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMAXV

Signed maximum reduction to scalar.

Signed maximum horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as the minimum signed integer for the element size.



SVE

```
SMAXV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
boolean unsigned = FALSE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer maximum = if unsigned then 0 else -(2^(esize-1));

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer element = Int(Elem[operand, e, esize], unsigned);
        maximum = Max(maximum, element);

V[d] = maximum<esize-1:0>;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

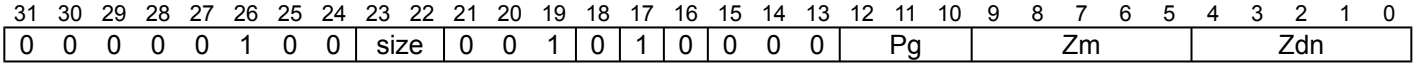
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMIN (vectors)

Signed minimum vectors (predicated).

Determine the signed minimum of active elements of the second source vector and corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SMIN <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer minimum = Min(element1, element2);
        Elem[result, e, esize] = minimum<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

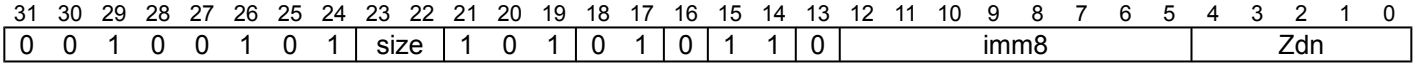
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SMIN (immediate)

Signed minimum with immediate (unpredicated).

Determine the signed minimum of an immediate and each element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is a signed 8-bit value in the range -128 to +127, inclusive. This instruction is unpredicated.



SVE

```
SMIN <Zdn>.<T>, <Zdn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
boolean unsigned = FALSE;
integer imm = Int(imm8, unsigned);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is the signed immediate operand, in the range -128 to 127, encoded in the "imm8" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    Elem[result, e, esize] = Min(element1, imm)<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

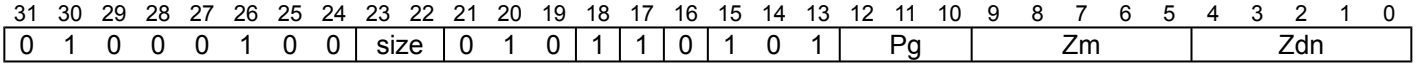
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

SMINP

Signed minimum pairwise.

Compute the minimum value of each pair of adjacent signed integer elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
SMINP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer element1;
integer element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand1, e, esize];
    else
        if IsEven(e) then
            element1 = SInt(Elem[operand1, e + 0, esize]);
            element2 = SInt(Elem[operand1, e + 1, esize]);
        else
            element1 = SInt(Elem[operand2, e - 1, esize]);
            element2 = SInt(Elem[operand2, e + 0, esize]);
        integer res = Min(element1, element2);
        Elem[result, e, esize] = res<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

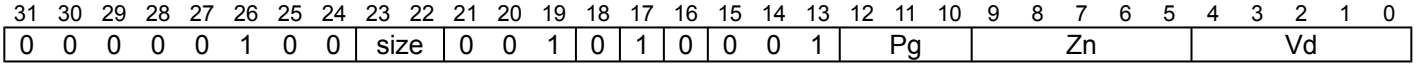
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMINV

Signed minimum reduction to scalar.

Signed minimum horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as the maximum signed integer for the element size.



SVE

```
SMINV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
boolean unsigned = FALSE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer minimum = if unsigned then (2^esize - 1) else (2^(esize-1) - 1);

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer element = Int(Elem[operand, e, esize], unsigned);
        minimum = Min(minimum, element);

V[d] = minimum<esize-1:0>;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

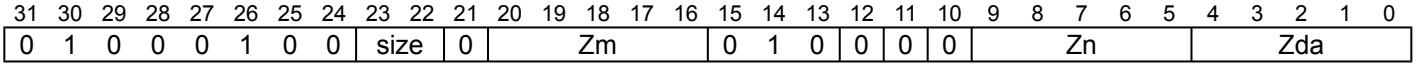
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMLALB (vectors)

Signed multiply-add long to accumulator (bottom).

Multiply the corresponding even-numbered signed elements of the first and second source vectors and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
SMLALB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

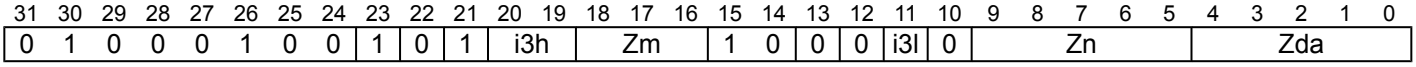
SMLALB (indexed)

Signed multiply-add long to accumulator (bottom, indexed).

Multiply the even-numbered signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment and destructively add to the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

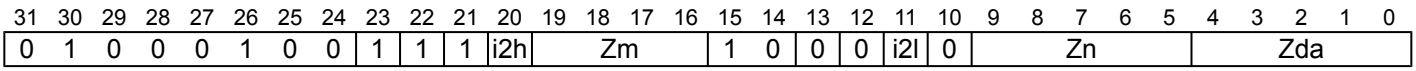


32-bit

```
SMLALB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

64-bit



64-bit

```
SMLALB <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

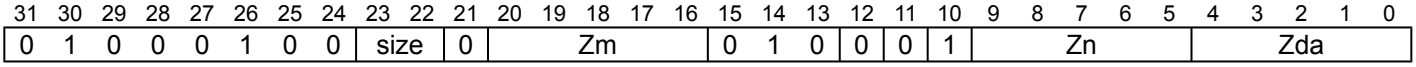
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SMLALT (vectors)

Signed multiply-add long to accumulator (top).

Multiply the corresponding odd-numbered signed elements of the first and second source vectors and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
SMLALT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

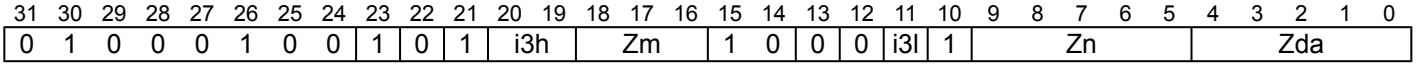
SMLALT (indexed)

Signed multiply-add long to accumulator (top, indexed).

Multiply the odd-numbered signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment and destructively add to the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

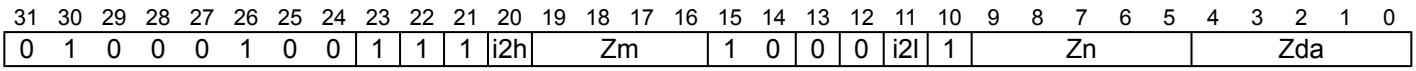


32-bit

```
SMLALT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

64-bit



64-bit

```
SMLALT <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

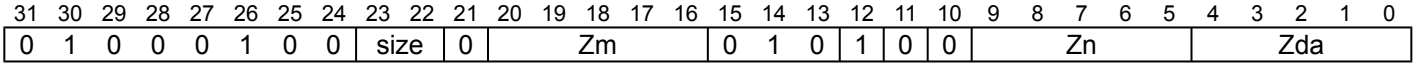
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SMLSLB (vectors)

Signed multiply-subtract long from accumulator (bottom).

Multiply the corresponding even-numbered signed elements of the first and second source vectors and destructively subtract from the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
SMLSLB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

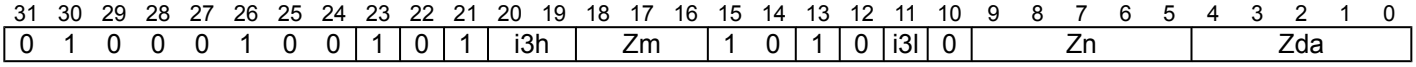
SMLSLB (indexed)

Signed multiply-subtract long from accumulator (bottom, indexed).

Multiply the even-numbered signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment and destructively subtract from the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

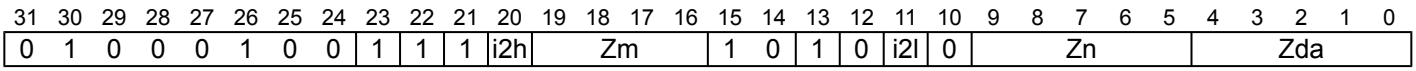


32-bit

```
SMLSLB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

64-bit



64-bit

```
SMLSLB <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

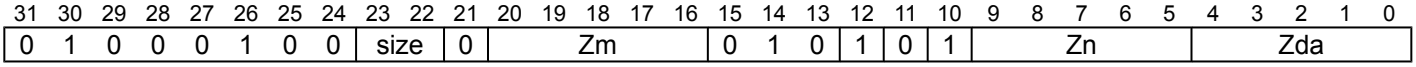
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMLSLT (vectors)

Signed multiply-subtract long from accumulator (top).

Multiply the corresponding odd-numbered signed elements of the first and second source vectors and destructively subtract from the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
SMLSLT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

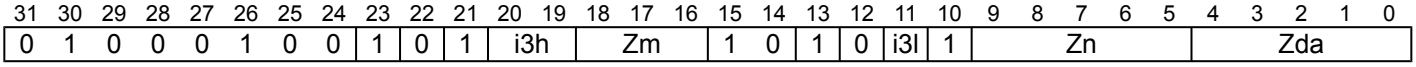
SMLSLT (indexed)

Signed multiply-subtract long from accumulator (top, indexed).

Multiply the odd-numbered signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment and destructively subtract from the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

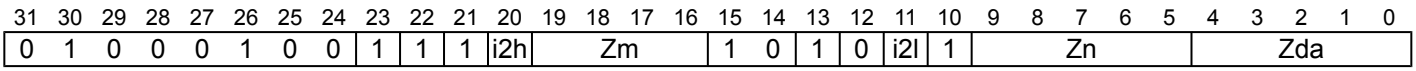


32-bit

```
SMLSLT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

64-bit



64-bit

```
SMLSLT <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

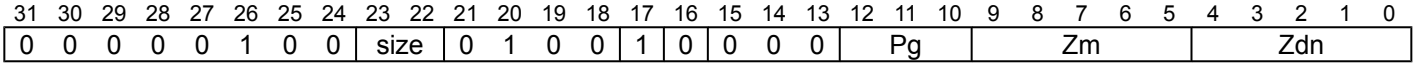
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SMULH (predicated)

Signed multiply returning high half (predicated).

Widening multiply signed integer values in active elements of the first source vector by corresponding elements of the second source vector and destructively place the high half of the result in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SMULH <Zdn>.<T>, <Pg>/M, <Zdn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer product = (element1 * element2) >> esize;
        Elem[result, e, esize] = product<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

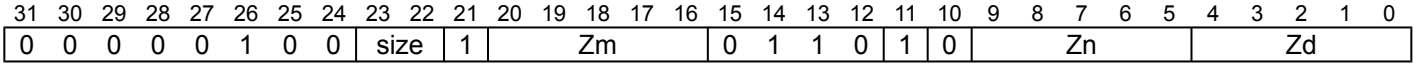
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMULH (unpredicated)

Signed multiply returning high half (unpredicated).

Widening multiply signed integer values of all elements of the first source vector by corresponding elements of the second source vector and place the high half of the result in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
SMULH <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    integer product = (element1 * element2) >> esize;
    Elem[result, e, esize] = product<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

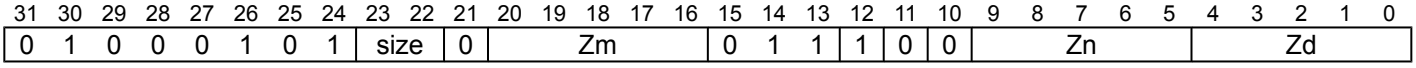
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

SMULLB (vectors)

Signed multiply long (bottom).

Multiply the corresponding even-numbered signed elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SMULLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer res = element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

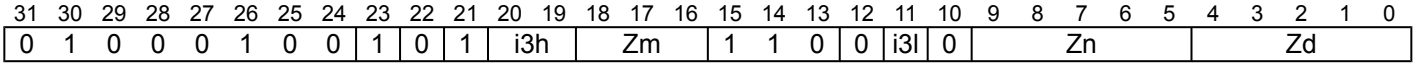
SMULLB (indexed)

Signed multiply long (bottom, indexed).

Multiply the even-numbered signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment, and place the results in the overlapping double-width elements of the destination vector register. The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

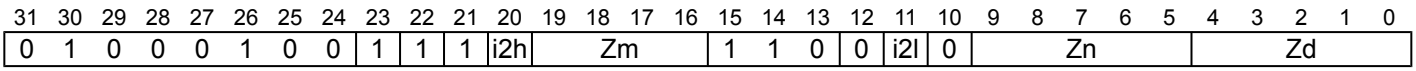


32-bit

```
SMULLB <Zd>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 0;
```

64-bit



64-bit

```
SMULLB <Zd>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 0;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer res = element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

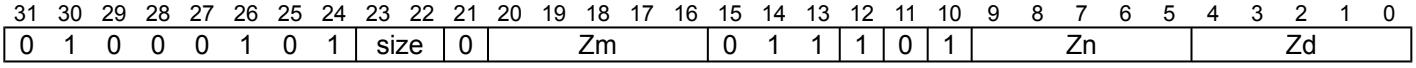
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SMULLT (vectors)

Signed multiply long (top).

Multiply the corresponding odd-numbered signed elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SMULLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer res = element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

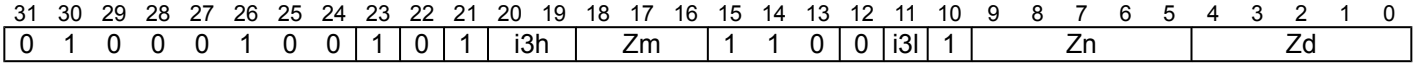
SMULLT (indexed)

Signed multiply long (top, indexed).

Multiply the odd-numbered signed elements within each 128-bit segment of the first source vector by the specified element in the corresponding second source vector segment, and place the results in the overlapping double-width elements of the destination vector register.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

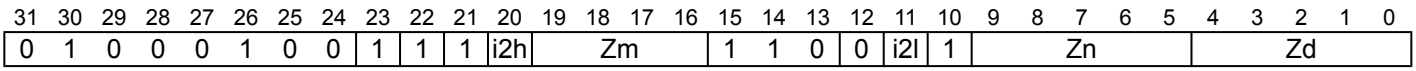
32-bit



32-bit

```
SMULLT <Zd>.S, <Zn>.H, <Zm>.H[<imm>]

if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 1;
```

64-bit



64-bit

```
SMULLT <Zd>.D, <Zn>.S, <Zm>.S[<imm>]

if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 1;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer res = element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

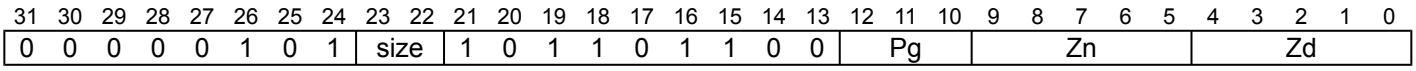
SPLICE

Splice two vectors under predicate control.

Copy the first active to last active elements (inclusive) from the first source vector to the lowest-numbered elements of the result. Then set any remaining elements of the result to a copy of the lowest-numbered elements from the second source vector. The result is placed destructively in the destination and first source vector, or constructively in the destination vector.

It has encodings from 2 classes: Constructive and Destructive

Constructive

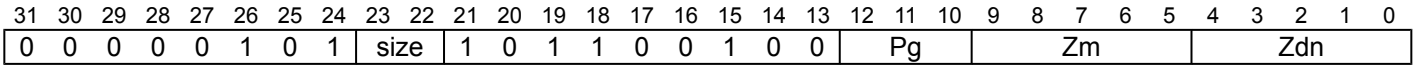


Constructive

```
SPLICE <Zd>.<T>, <Pg>, { <Zn1>.<T>, <Zn2>.<T> }
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dst = UInt(Zd);
integer s1 = UInt(Zn);
integer s2 = (s1 + 1) MOD 32;
```

Destructive



Destructive

```
SPLICE <Zdn>.<T>, <Pg>, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dst = UInt(Zdn);
integer s1 = dst;
integer s2 = UInt(Zm);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn1> Is the name of the first scalable vector register of a multi-vector sequence, encoded in the "Zn" field.

<Zn2> Is the name of the second scalable vector register of a multi-vector sequence, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[s1];
bits(VL) operand2 = Z[s2];
bits(VL) result;
integer x = 0;
boolean active = FALSE;
integer lastnum = LastActiveElement(mask, esize);

if lastnum >= 0 then
    for e = 0 to lastnum
        active = active || ElemP[mask, e, esize] == '1';
        if active then
            Elem[result, x, esize] = Elem[operand1, e, esize];
            x = x + 1;

elements = elements - x - 1;
for e = 0 to elements
    Elem[result, x, esize] = Elem[operand2, e, esize];
    x = x + 1;

Z[dst] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

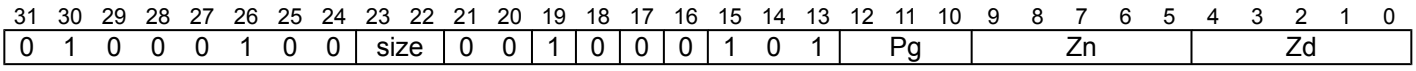
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQABS

Signed saturating absolute value.

Compute the absolute value of the signed integer in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQABS <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    integer element = SInt(Elem[operand, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        element = Abs(element);
        Elem[result, e, esize] = SignedSat(element, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

- The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

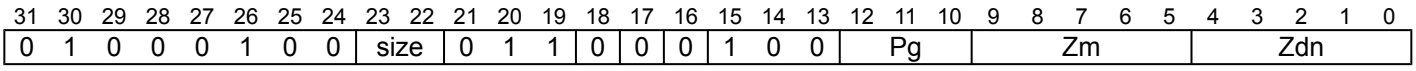
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQADD (vectors, predicated)

Signed saturating addition (predicated).

Add active signed elements of the first source vector to corresponding signed elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = SInt(Sat(element1 + element2, esize, unsigned));
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

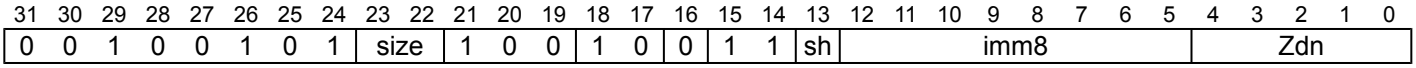
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQADD (immediate)

Signed saturating add immediate (unpredicated).

Signed saturating add of an unsigned immediate to each element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.
The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.
The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
SQADD <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + imm, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

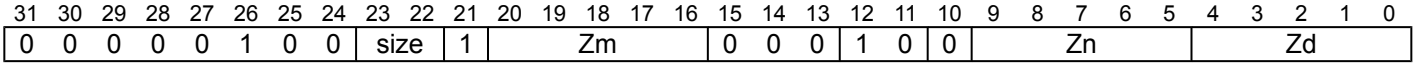
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQADD (vectors, unpredicated)

Signed saturating add vectors (unpredicated).

Signed saturating add all elements of the second source vector to corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE

```
SQADD <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + element2, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

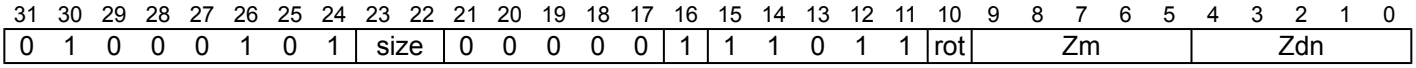
(old) htmldiff from- (new)

SQCADD

Saturating complex integer add with rotate.

Add the real and imaginary components of the integral complex numbers from the first source vector to the complex numbers from the second source vector which have first been rotated by 90 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation, equivalent to multiplying the complex numbers in the second source vector by ±i beforehand. Destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.



SVE2

```
SQCADD <Zdn>.<T>, <Zdn>.<T>, <Zm>.<T>, <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
boolean sub_i = (rot == '0');
boolean sub_r = (rot == '1');
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
0	#90
1	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for p = 0 to pairs-1
    integer acc_r  = SInt(Elem[operand1, 2 * p + 0, esize]);
    integer acc_i  = SInt(Elem[operand1, 2 * p + 1, esize]);
    integer elt2_r = SInt(Elem[operand2, 2 * p + 0, esize]);
    integer elt2_i = SInt(Elem[operand2, 2 * p + 1, esize]);
    if sub_i then
        acc_r = acc_r - elt2_i;
        acc_i = acc_i + elt2_r;
    if sub_r then
        acc_r = acc_r + elt2_i;
        acc_i = acc_i - elt2_r;

    Elem[result, 2 * p + 0, esize] = SignedSat(acc_r, esize);
    Elem[result, 2 * p + 1, esize] = SignedSat(acc_i, esize);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDECB

Signed saturating decrement scalar by multiple of 8-bit predicate constraint element count.

Determines the number of active 8-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

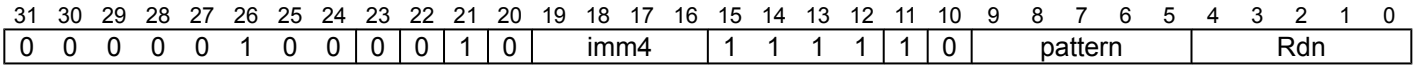
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

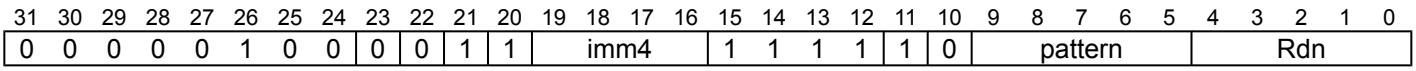


32-bit

```
SQDECB <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQDECB <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDECD (scalar)

Signed saturating decrement scalar by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

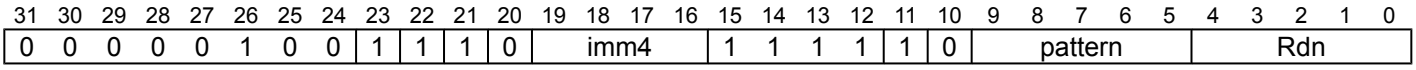
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

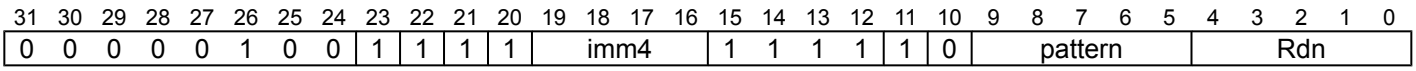


32-bit

```
SQDECD <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQDECD <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

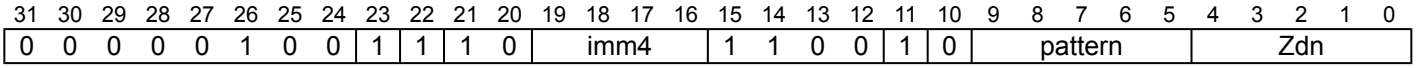
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDECD (vector)

Signed saturating decrement vector by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements. The results are saturated to the 64-bit signed integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
SQDECD <Zdn>.D{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDECH (scalar)

Signed saturating decrement scalar by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

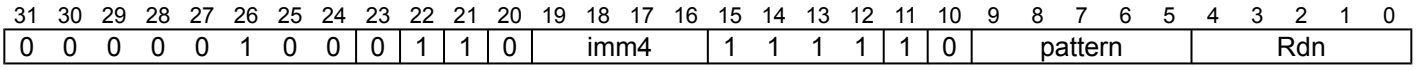
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

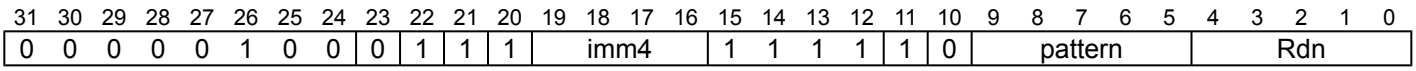


32-bit

```
SQDECH <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQDECH <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

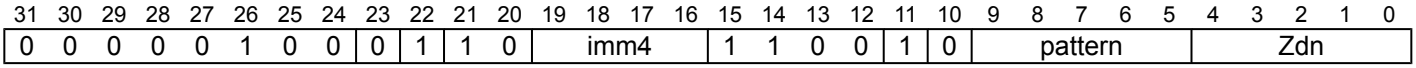
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDECH (vector)

Signed saturating decrement vector by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements. The results are saturated to the 16-bit signed integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
SQDECH <Zdn>.H{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

(old) htmldiff from- (new)

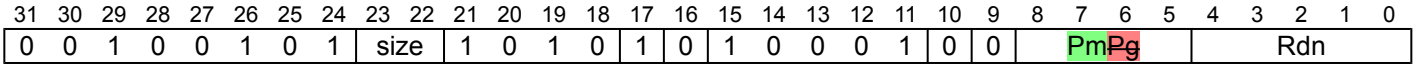
SQDECP (scalar)

Signed saturating decrement scalar by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to decrement the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

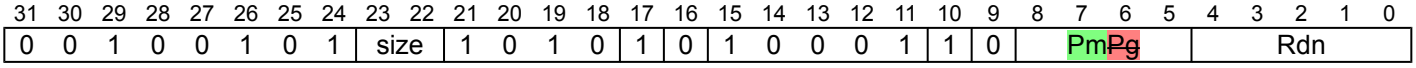


32-bit

```
SQDECP <Xdn>, <Pm><Pg>.<T>, <Wdn>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQDECP <Xdn>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(ssize) operand1 =bits(PL) mask = P[g];
bits(ssize) operand = X[dn];
bits(PL) operand2 = P[m];
[dn];
bits(ssize) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

integer element = Int(operand1, unsigned);
(operand, unsigned);
(result, -) = SatQ(element - count, ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

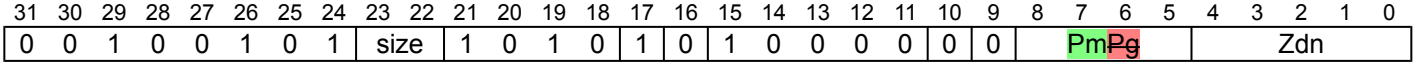
(old) htmldiff from- (new)

SQDECP (vector)

Signed saturating decrement vector by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to decrement all destination vector elements. The results are saturated to the element signed integer range.

The predicate size specifier may be omitted in assembler source code, but this is deprecated and will be prohibited in a future release of the architecture.



SVE

```
SQDECP <Zdn>.<T>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Zdn);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 =bits(PL) mask = P[g];
bits(VL) operand = Z[dn];
bits(PL) operand2 = P[m];
[dn];
bits(VL) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

for e = 0 to elements-1
    integer element = Int(Elem[operand1, e, esize], unsigned);
[operand, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element - count, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDECW (scalar)

Signed saturating decrement scalar by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

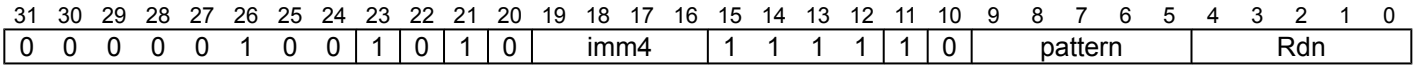
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

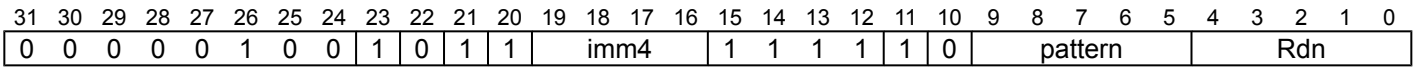


32-bit

```
SQDECW <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQDECW <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

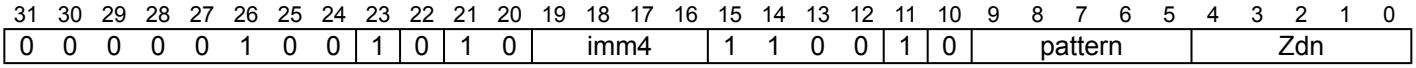
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDECW (vector)

Signed saturating decrement vector by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements. The results are saturated to the 32-bit signed integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
SQDECW <Zdn>.S{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

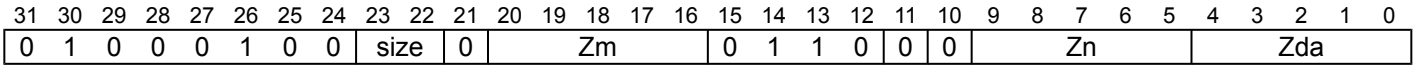
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDMLALB (vectors)

Signed saturating doubling multiply-add long to accumulator (bottom).

Multiply then double the corresponding even-numbered signed elements of the first and second source vectors. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively add to the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMLALB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel1 = 0;
integer sel2 = 0;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2 * e + sel1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2 * e + sel2, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, esize));
    Elem[result, e, esize] = SignedSat(element3 + product, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

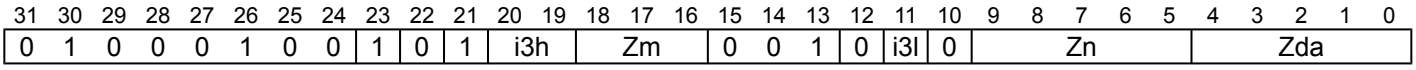
SQDMLALB (indexed)

Signed saturating doubling multiply-add long to accumulator (bottom, indexed).

Multiply then double the even-numbered signed elements within each 128-bit segment of the first source vector and specified signed element in the corresponding second source vector segment. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively add to the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

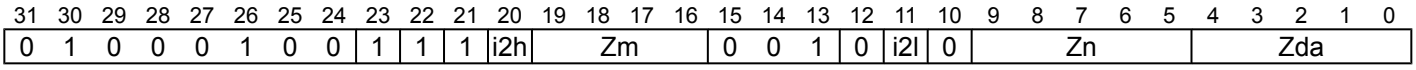


32-bit

```
SQDMLALB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

64-bit



64-bit

```
SQDMLALB <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, 2*esize));
    integer res = element3 + product;
    Elem[result, e, 2*esize] = SignedSat(res, 2*esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

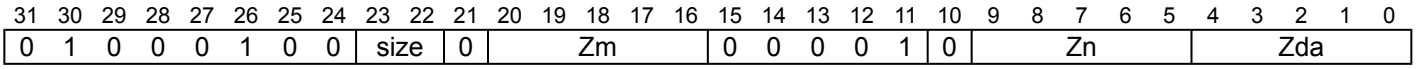
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDMLALBT

Signed saturating doubling multiply-add long to accumulator (bottom × top).

Multiply then double the corresponding even-numbered signed elements of the first and odd-numbered signed elements of the second source vector. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively add to the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMLALBT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel1 = 0;
integer sel2 = 1;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2 * e + sel1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2 * e + sel2, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, esize));
    Elem[result, e, esize] = SignedSat(element3 + product, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

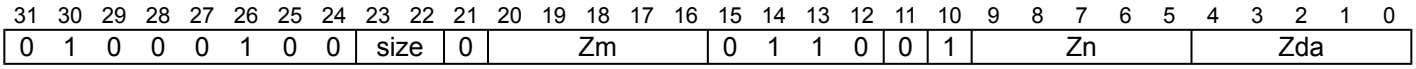
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDMLALT (vectors)

Signed saturating doubling multiply-add long to accumulator (top).

Multiply then double the corresponding odd-numbered signed elements of the first and second source vectors. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively add to the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMLALT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel1 = 1;
integer sel2 = 1;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2 * e + sel1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2 * e + sel2, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, esize));
    Elem[result, e, esize] = SignedSat(element3 + product, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

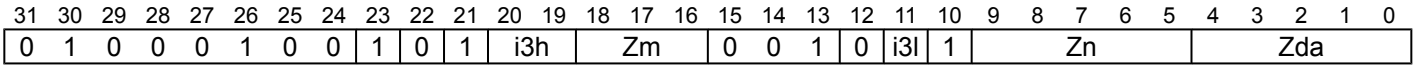
SQDMLALT (indexed)

Signed saturating doubling multiply-add long to accumulator (top, indexed).

Multiply then double the odd-numbered signed elements within each 128-bit segment of the first source vector and the specified signed element in the corresponding second source vector segment. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively add to the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

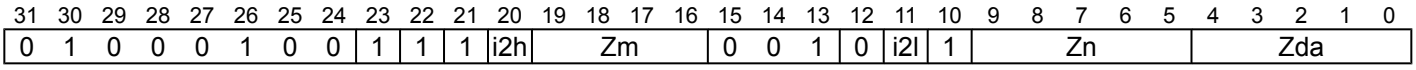


32-bit

```
SQDMLALT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

64-bit



64-bit

```
SQDMLALT <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, 2*esize));
    integer res = element3 + product;
    Elem[result, e, 2*esize] = SignedSat(res, 2*esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

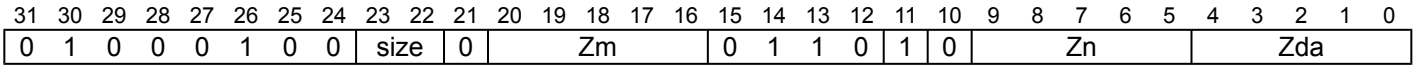
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDMLSLB (vectors)

Signed saturating doubling multiply-subtract long from accumulator (bottom).

Multiply then double the corresponding even-numbered signed elements of the first and second source vectors. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively subtract from the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMLSLB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel1 = 0;
integer sel2 = 0;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2 * e + sel1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2 * e + sel2, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, esize));
    Elem[result, e, esize] = SignedSat(element3 - product, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

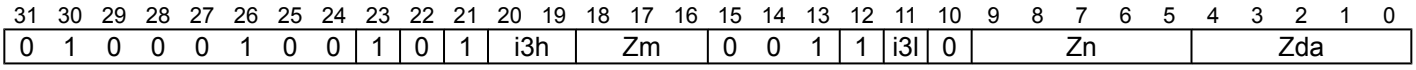
SQDMLSLB (indexed)

Signed saturating doubling multiply-subtract long from accumulator (bottom, indexed).

Multiply then double the even-numbered signed elements within each 128-bit segment of the first source vector and the specified signed element in the corresponding second source vector segment. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively subtract from the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

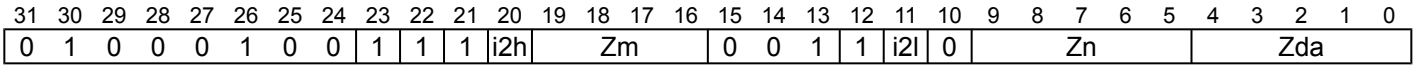


32-bit

```
SQDMLSLB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

64-bit



64-bit

```
SQDMLSLB <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, 2*esize));
    integer res = element3 - product;
    Elem[result, e, 2*esize] = SignedSat(res, 2*esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

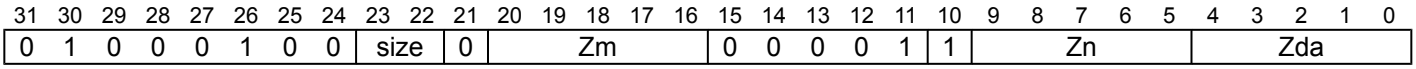
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDMLSLBT

Signed saturating doubling multiply-subtract long from accumulator (bottom × top).

Multiply then double the corresponding even-numbered signed elements of the first and odd-numbered signed elements of the second source vector. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively subtract from the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMLSLBT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel1 = 0;
integer sel2 = 1;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2 * e + sel1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2 * e + sel2, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, esize));
    Elem[result, e, esize] = SignedSat(element3 - product, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

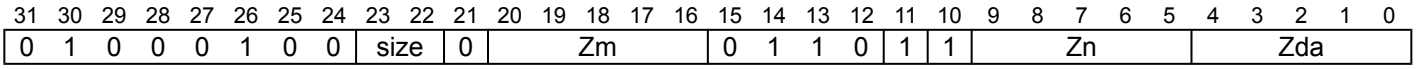
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDMLSLT (vectors)

Signed saturating doubling multiply-subtract long from accumulator (top).

Multiply then double the corresponding odd-numbered signed elements of the first and second source vectors. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively subtract from the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMLSLT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel1 = 1;
integer sel2 = 1;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2 * e + sel1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2 * e + sel2, esize DIV 2]);
    integer element3 = SInt(Elem[result, e, esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, esize));
    Elem[result, e, esize] = SignedSat(element3 - product, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

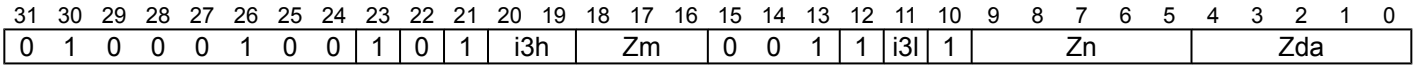
SQDMLSLT (indexed)

Signed saturating doubling multiply-subtract long from accumulator (top, indexed).

Multiply then double the odd-numbered signed elements within each 128-bit segment of the first source vector and the specified signed element in the corresponding second source vector segment. Each intermediate value is saturated to the double-width N-bit value's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Then destructively subtract from the overlapping double-width elements of the addend and destination vector. Each destination element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

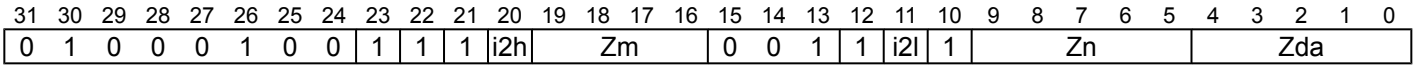
32-bit



32-bit

```
SQDMLSLT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]

if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

64-bit



64-bit

```
SQDMLSLT <Zda>.D, <Zn>.S, <Zm>.S[<imm>]

if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = SInt(Elem[result, e, 2*esize]);
    integer product = SInt(SignedSat(2 * element1 * element2, 2*esize));
    integer res = element3 - product;
    Elem[result, e, 2*esize] = SignedSat(res, 2*esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

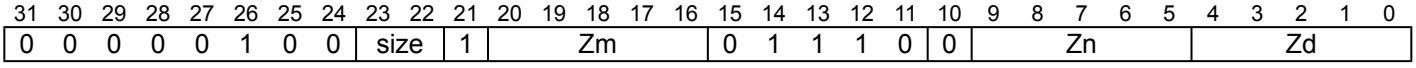
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDMULH (vectors)

Signed saturating doubling multiply high (unpredicated).

Multiply then double the corresponding signed elements of the first and second source vectors, and place the most significant half of the results in the corresponding elements of the destination vector register. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMULH <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    integer res = 2 * element1 * element2;
    Elem[result, e, esize] = SignedSat(res >> esize, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

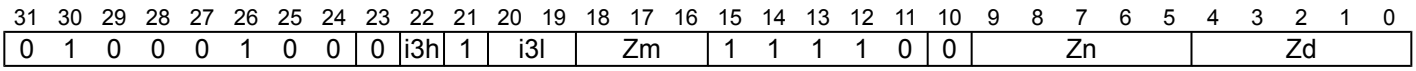
SQDMULH (indexed)

Signed saturating doubling multiply high (indexed).

Multiply all signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment, double and place the most significant half of the result in the corresponding elements of the destination vector register. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

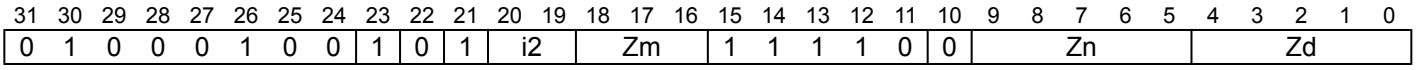


16-bit

```
SQDMULH <Zd>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

32-bit

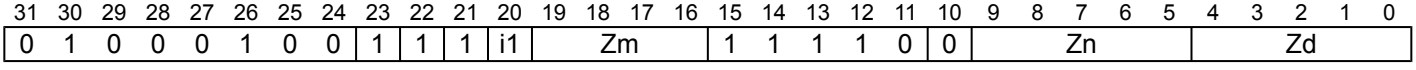


32-bit

```
SQDMULH <Zd>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

64-bit



64-bit

```
SQDMULH <Zd>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, s, esize]);
    integer res = 2 * element1 * element2;
    Elem[result, e, esize] = SignedSat(res >> esize, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

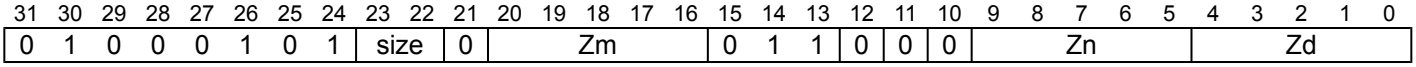
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQDMULLB (vectors)

Signed saturating doubling multiply long (bottom).

Multiply the corresponding even-numbered signed elements of the first and second source vectors, double and place the results in the overlapping double-width elements of the destination vector. Each result element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMULLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer res = 2 * element1 * element2;
    Elem[result, e, esize] = SignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

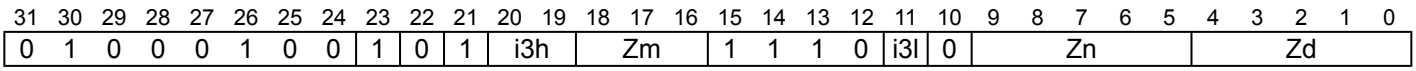
SQDMULLB (indexed)

Signed saturating doubling multiply long (bottom, indexed).

Multiply then double the even-numbered signed elements within each 128-bit segment of the first source vector and the specified element in the corresponding second source vector segment, and place the results in overlapping double-width elements of the destination vector register. Each result element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

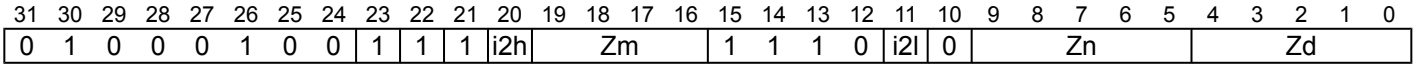


32-bit

```
SQDMULLB <Zd>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 0;
```

64-bit



64-bit

```
SQDMULLB <Zd>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 0;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer res = 2 * element1 * element2;
    Elem[result, e, 2*esize] = SignedSat(res, 2*esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

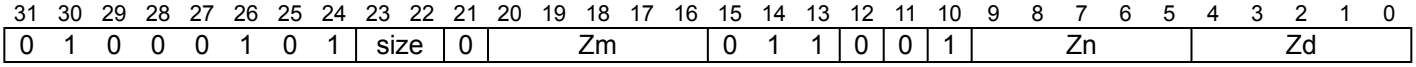
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQDMULLT (vectors)

Signed saturating doubling multiply long (top).

Multiply the corresponding odd-numbered signed elements of the first and second source vectors, double and place the results in the overlapping double-width elements of the destination vector. Each result element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQDMULLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer res = 2 * element1 * element2;
    Elem[result, e, esize] = SignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

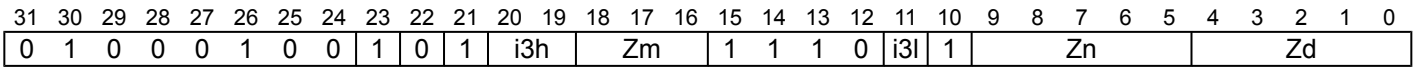
SQDMULLT (indexed)

Signed saturating doubling multiply long (top, indexed).

Multiply then double the odd-numbered signed elements within each 128-bit segment of the first source vector and the specified element in the corresponding second source vector segment, and place the results in overlapping double-width elements of the destination vector register. Each result element is saturated to the double-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

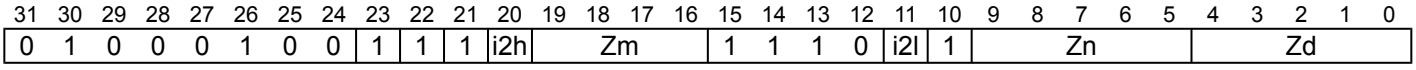


32-bit

```
SQDMULLT <Zd>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 1;
```

64-bit



64-bit

```
SQDMULLT <Zd>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 1;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = SInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = SInt(Elem[operand2, 2 * s + index, esize]);
    integer res = 2 * element1 * element2;
    Elem[result, e, 2*esize] = SignedSat(res, 2*esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCB

Signed saturating increment scalar by multiple of 8-bit predicate constraint element count.

Determines the number of active 8-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

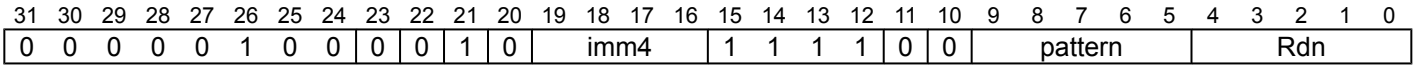
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

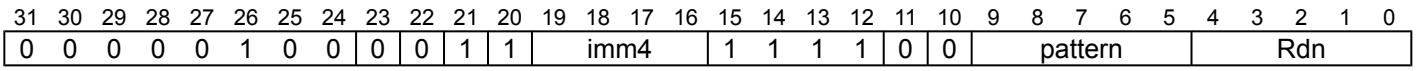


32-bit

```
SQINCB <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQINCB <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCD (scalar)

Signed saturating increment scalar by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

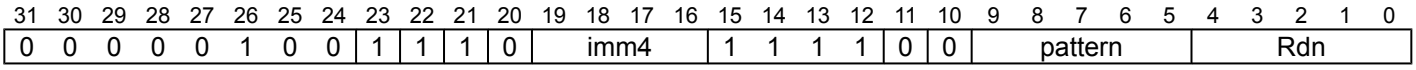
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

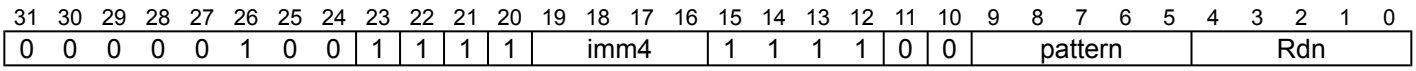


32-bit

```
SQINCD <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQINCD <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

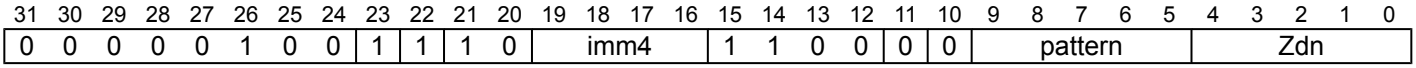
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCD (vector)

Signed saturating increment vector by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements. The results are saturated to the 64-bit signed integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
SQINCD <Zdn>.D{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCH (scalar)

Signed saturating increment scalar by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

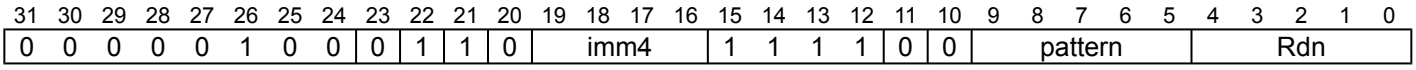
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

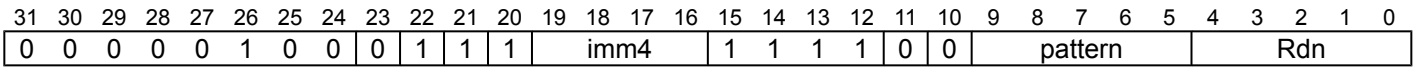


32-bit

```
SQINCH <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQINCH <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

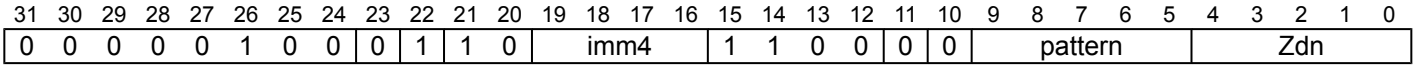
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCH (vector)

Signed saturating increment vector by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements. The results are saturated to the 16-bit signed integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
SQINCH <Zdn>.H{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

(old) htmldiff from- (new)

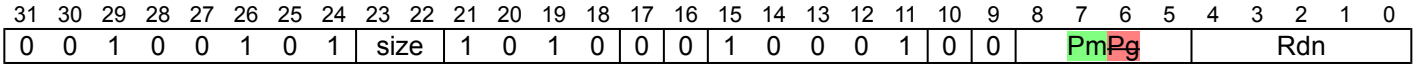
SQINCP (scalar)

Signed saturating increment scalar by countactive ofpredicate trueelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to increment the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

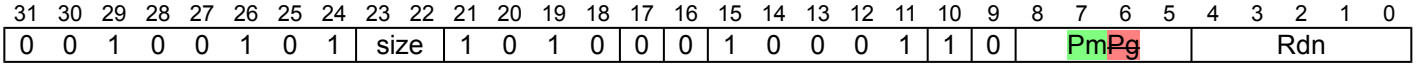


32-bit

```
SQINCP <Xdn>, <Pm><Pg>.<T>, <Wdn>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQINCP <Xdn>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(ssize) operand1 =bits(PL) mask = P[g];
bits(ssize) operand = X[dn];
bits(PL) operand2 = P[m];
[dn];
bits(ssize) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

integer element = Int(operand1, unsigned);
(operand, unsigned);
(result, -) = SatQ(element + count, ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

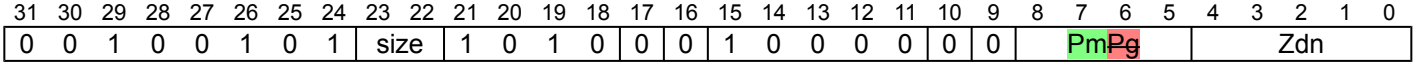
Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

(old) htmldiff from- (new)

SQINCP (vector)

Signed saturating increment vector by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to increment all destination vector elements. The results are saturated to the element signed integer range.
The predicate size specifier may be omitted in assembler source code, but this is deprecated and will be prohibited in a future release of the architecture.



SVE

```
SQINCP <Zdn>.<T>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Zdn);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 =bits(PL) mask = P[g];
bits(VL) operand = Z[dn];
bits(PL) operand2 = P[m];
[dn];
bits(VL) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

for e = 0 to elements-1
    integer element = Int(Elem[operand1, e, esize], unsigned);
[operand, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element + count, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCW (scalar)

Signed saturating increment scalar by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the source general-purpose register's signed integer range. A 32-bit saturated result is then sign-extended to 64 bits.

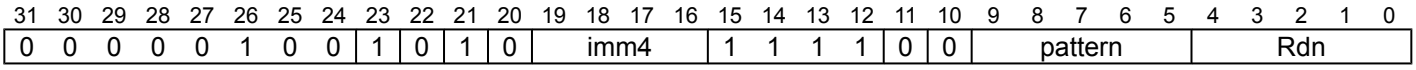
The named predicate constraint limits the number of active elements in a single predicate to:

* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).

Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

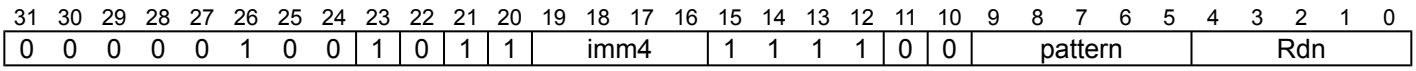


32-bit

```
SQINCW <Xdn>, <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 32;
```

64-bit



64-bit

```
SQINCW <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
integer ssize = 64;
```

Assembler Symbols

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

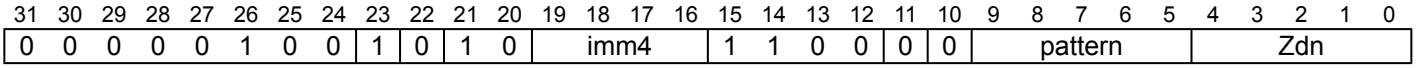
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQINCW (vector)

Signed saturating increment vector by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements. The results are saturated to the 32-bit signed integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
SQINCW <Zdn>.S{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

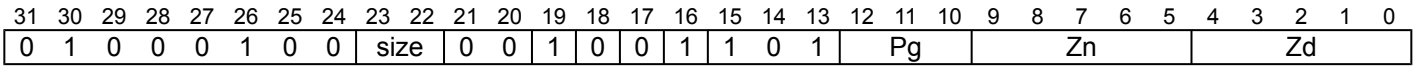
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQNEG

Signed saturating negate.

Negate the signed integer value in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQNEG <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    integer element = SInt(Elem[operand, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        element = -element;
        Elem[result, e, esize] = SignedSat(element, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRDCMLAH (vectors)

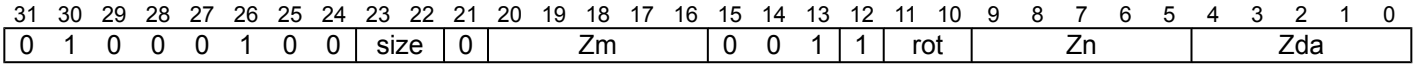
Saturating rounding doubling complex integer multiply-add high with rotate.

Multiply without saturation the duplicated real components for rotations 0 and 180, or imaginary components for rotations 90 and 270, of the integral numbers in the first source vector by the corresponding complex number in the second source vector rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation.

Then double and add the products to the corresponding components of the complex numbers in the addend vector. Destructively place the most significant rounded half of the results in the corresponding elements of the addend vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.

These transformations permit the creation of a variety of multiply-add and multiply-subtract operations on complex numbers by combining two of these instructions with the same vector operands but with rotations that are 90 degrees apart.

Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.



SVE2

```
SQRDCMLAH <Zda>.<T>, <Zn>.<T>, <Zm>.<T>, <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_r = (rot<0> != rot<1>);
boolean sub_i = (rot<1> == '1');
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

integer round_const = 1 << (esize-1);
integer res_r, res_i;

for p = 0 to pairs-1
    integer elt1_a = SInt(Elem[operand1, 2 * p + sel_a, esize]);
    integer elt2_a = SInt(Elem[operand2, 2 * p + sel_a, esize]);
    integer elt2_b = SInt(Elem[operand2, 2 * p + sel_b, esize]);
    bits(esize) elt3_r = Elem[operand3, 2 * p + 0, esize];
    bits(esize) elt3_i = Elem[operand3, 2 * p + 1, esize];
    integer product_r =  elt1_a * elt2_a;
    integer product_i =  elt1_a * elt2_b;
    if sub_r then
        res_r = (SInt(elt3_r) << esize) - 2 * product_r + round_const;
    else
        res_r = (SInt(elt3_r) << esize) + 2 * product_r + round_const;
    if sub_i then
        res_i = (SInt(elt3_i) << esize) - 2 * product_i + round_const;
    else
        res_i = (SInt(elt3_i) << esize) + 2 * product_i + round_const;
    Elem[result, 2 * p + 0, esize] = SignedSat(res_r >> esize, esize);
    Elem[result, 2 * p + 1, esize] = SignedSat(res_i >> esize, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRDCMLAH (indexed)

Saturating rounding doubling complex integer multiply-add high with rotate (indexed).

Multiply without saturation the duplicated real components for rotations 0 and 180, or imaginary components for rotations 90 and 270, of the integral numbers in each 128-bit segment of the first source vector by the specified complex number in the corresponding the second source vector segment rotated by 0, 90, 180 or 270 degrees in the direction from the positive real axis towards the positive imaginary axis, when considered in polar representation.
Then double and add the products to the corresponding components of the complex numbers in the addend vector. Destructively place the most significant rounded half of the results in the corresponding elements of the addend vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.
These transformations permit the creation of a variety of multiply-add and multiply-subtract operations on complex numbers by combining two of these instructions with the same vector operands but with rotations that are 90 degrees apart.
Each complex number is represented in a vector register as an even/odd pair of elements with the real part in the even-numbered element and the imaginary part in the odd-numbered element.

It has encodings from 2 classes: 16-bit and 32-bit

16-bit

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	1	0	0	1	0	1	i2		Zm			0	1	1	1	rot		Zn					Zda				

16-bit

```
SQRDCMLAH <Zda>.H, <Zn>.H, <Zm>.H[<imm>], <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_r = (rot<0> != rot<1>);
boolean sub_i = (rot<1> == '1');
```

32-bit

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	1	0	0	1	1	1	i1		Zm			0	1	1	1	rot		Zn					Zda				

32-bit

```
SQRDCMLAH <Zda>.S, <Zn>.S, <Zm>.S[<imm>], <const>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel_a = UInt(rot<0>);
integer sel_b = UInt(NOT(rot<0>));
boolean sub_r = (rot<0> != rot<1>);
boolean sub_i = (rot<1> == '1');
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> For the 16-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.

For the 32-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.

<imm> For the 16-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field.

For the 32-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

<const> Is the const specifier, encoded in “rot”:

rot	<const>
00	#0
01	#90
10	#180
11	#270

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (2 * esize);
integer pairspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

integer round_const = 1 << (esize-1);
integer res_r, res_i;

for p = 0 to pairs-1
    integer segmentbase = p - p MOD pairspersegment;
    integer s = segmentbase + index;
    integer elt1_a = SInt(Elem[operand1, 2 * p + sel_a, esize]);
    integer elt2_a = SInt(Elem[operand2, 2 * s + sel_a, esize]);
    integer elt2_b = SInt(Elem[operand2, 2 * s + sel_b, esize]);
    bits(esize) elt3_r = Elem[operand3, 2 * p + 0, esize];
    bits(esize) elt3_i = Elem[operand3, 2 * p + 1, esize];
    integer product_r =  elt1_a * elt2_a;
    integer product_i =  elt1_a * elt2_b;
    if sub_r then
        res_r = (SInt(elt3_r) << esize) - 2 * product_r + round_const;
    else
        res_r = (SInt(elt3_r) << esize) + 2 * product_r + round_const;
    if sub_i then
        res_i = (SInt(elt3_i) << esize) - 2 * product_i + round_const;
    else
        res_i = (SInt(elt3_i) << esize) + 2 * product_i + round_const;
    Elem[result, 2 * p + 0, esize] = SignedSat(res_r >> esize, esize);
    Elem[result, 2 * p + 1, esize] = SignedSat(res_i >> esize, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

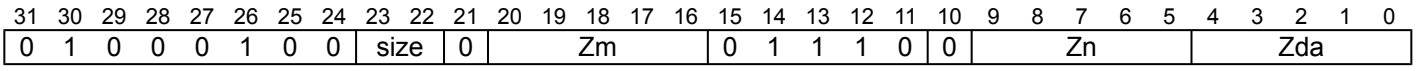
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRDMLAH (vectors)

Signed saturating rounding doubling multiply-add high to accumulator (unpredicated).

Multiply then double the corresponding signed elements of the first and second source vectors, and destructively add the rounded high half of each result to the corresponding elements of the addend and destination vector. Each destination element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQRDMLAH <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;
integer round_const = 1 << (esize - 1);

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    integer element3 = SInt(Elem[operand3, e, esize]);
    integer res = (element3 << esize) + (2 * element1 * element2);
    Elem[result, e, esize] = SignedSat((res + round_const) >> esize, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

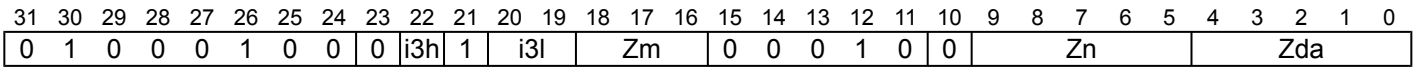
SQRDMLAH (indexed)

Signed saturating rounding doubling multiply-add high to accumulator (indexed).

Multiply then double all signed elements within each 128-bit segment of the first source vector and the specified signed element of the corresponding second source vector segment, and destructively add the rounded high half of each result to the corresponding elements of the addend and destination vector. Each destination element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

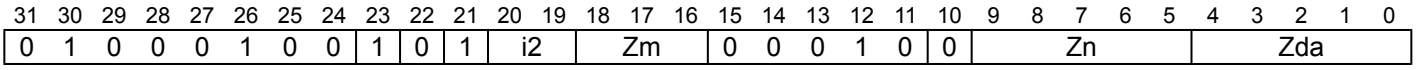


16-bit

```
SQRDMLAH <Zda>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

32-bit

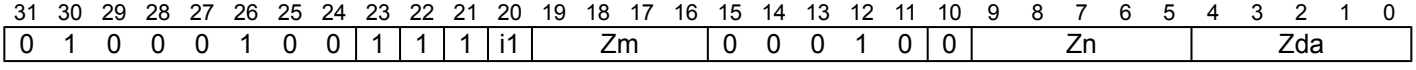


32-bit

```
SQRDMLAH <Zda>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

64-bit



64-bit

```
SQRDMLAH <Zda>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;
integer round_const = 1 << (esize - 1);

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, s, esize]);
    integer element3 = SInt(Elem[operand3, e, esize]);
    integer res = (element3 << esize) + (2 * element1 * element2);
    Elem[result, e, esize] = SignedSat((res + round_const) >> esize, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

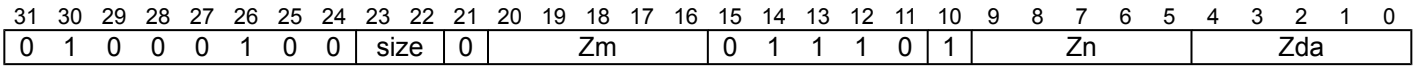
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRDMLSH (vectors)

Signed saturating rounding doubling multiply-subtract high from accumulator (unpredicated).

Multiply then double the corresponding signed elements of the first and second source vectors, and destructively subtract the rounded high half of each result from the corresponding elements of the addend and destination vector. Each destination element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQRDMLSH <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;
integer round_const = 1 << (esize - 1);

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    integer element3 = SInt(Elem[operand3, e, esize]);
    integer res = (element3 << esize) - (2 * element1 * element2);
    Elem[result, e, esize] = SignedSat((res + round_const) >> esize, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

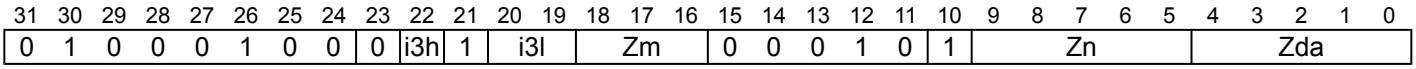
SQRDMLSH (indexed)

Signed saturating rounding doubling multiply-subtract high from accumulator (indexed).

Multiply then double all signed elements within each 128-bit segment of the first source vector and the specified signed element of the corresponding second source vector segment, and destructively subtract the rounded high half of each result to the corresponding elements of the addend and destination vector. Each destination element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

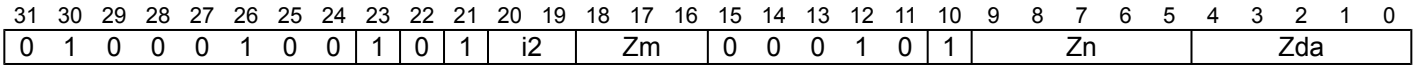


16-bit

```
SQRDMLSH <Zda>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

32-bit

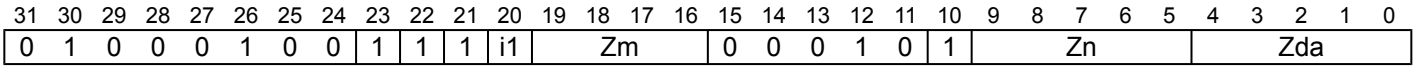


32-bit

```
SQRDMLSH <Zda>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

64-bit



64-bit

```
SQRDMLSH <Zda>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field.
	For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;
integer round_const = 1 << (esize - 1);

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, s, esize]);
    integer element3 = SInt(Elem[operand3, e, esize]);
    integer res = (element3 << esize) - (2 * element1 * element2);
    Elem[result, e, esize] = SignedSat((res + round_const) >> esize, esize);

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

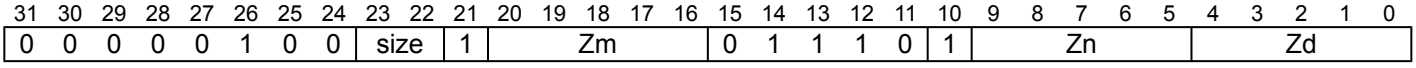
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRDMULH (vectors)

Signed saturating rounding doubling multiply high (unpredicated).

Multiply then double the corresponding signed elements of the first and second source vectors, and place the most significant rounded half of the result in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE2

```
SQRDMULH <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer round_const = 1 << (esize - 1);

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    integer res = 2 * element1 * element2;
    Elem[result, e, esize] = SignedSat((res + round_const) >> esize, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

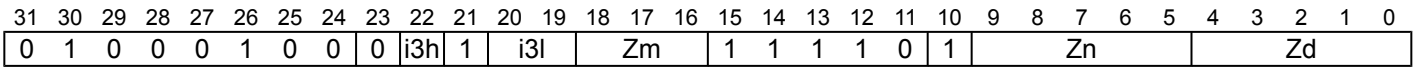
SQRDMULH (indexed)

Signed saturating rounding doubling multiply high (indexed).

Multiply all signed elements within each 128-bit segment of the first source vector by the specified signed element in the corresponding second source vector segment, double and place the most significant rounded half of the result in the corresponding elements of the destination vector register. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 1 to 3 bits depending on the size of the element.

It has encodings from 3 classes: 16-bit , 32-bit and 64-bit

16-bit

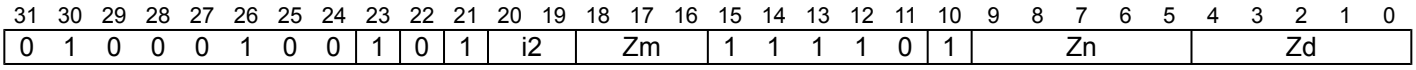


16-bit

```
SQRDMULH <Zd>.H, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

32-bit

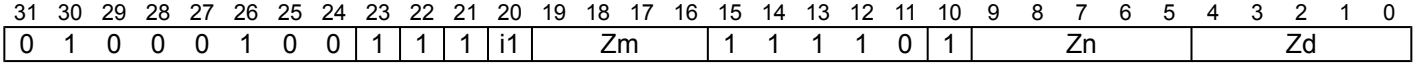


32-bit

```
SQRDMULH <Zd>.S, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

64-bit



64-bit

```
SQRDMULH <Zd>.D, <Zn>.D, <Zm>.D[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 16-bit and 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 16-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields. For the 32-bit variant: is the element index, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the element index, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer round_const = 1 << (esize - 1);

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, s, esize]);
    integer res = 2 * element1 * element2;
    Elem[result, e, esize] = SignedSat((res + round_const) >> esize, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

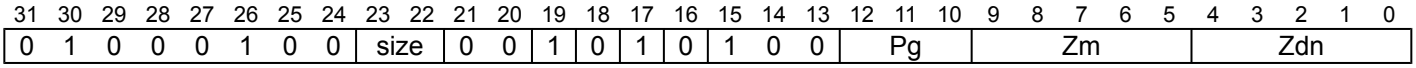
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQRSHL

Signed saturating rounding shift left by vector (predicated).

Shift active signed elements of the first source vector by corresponding elements of the second source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQRSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = SignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQRSHLR

Signed saturating rounding shift left reversed vectors (predicated).

Shift active signed elements of the second source vector by corresponding elements of the first source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	1	0	0	size		0	0	1	1	1	0	1	0	0	Pg			Zm					Zdn				

SVE2

```
SQRSHLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[m];
bits(VL) operand2 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = SignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand2, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

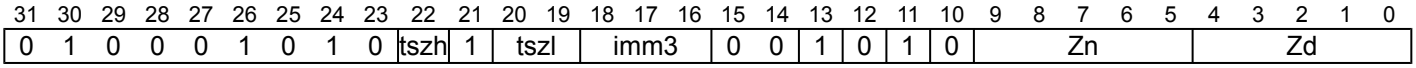
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRSHRNB

Signed saturating rounding shift right narrow by immediate (bottom).

Shift each signed integer value in the source vector elements right by an immediate value, and place the rounded results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. Each result element is saturated to the half-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQRSHRNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (SInt(element) + round_const) >> shift;
    Elem[result, 2*e + 0, esize] = SignedSat(res, esize);
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

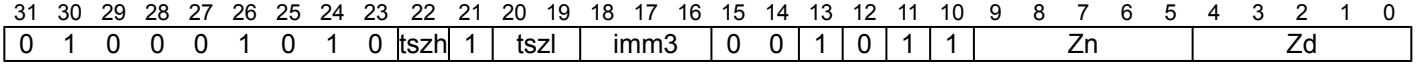
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRSHRNT

Signed saturating rounding shift right narrow by immediate (top).

Shift each signed integer value in the source vector elements right by an immediate value, and place the rounded results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. Each result element is saturated to the half-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQRSHRNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (SInt(element) + round_const) >> shift;
    Elem[result, 2*e + 1, esize] = SignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

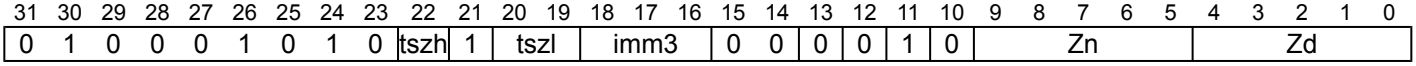
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRSHRUNB

Signed saturating rounding shift right unsigned narrow by immediate (bottom).

Shift each signed integer value in the source vector elements right by an immediate value, and place the rounded results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQRSHRUNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (SInt(element) + round_const) >> shift;
    Elem[result, 2*e + 0, esize] = UnsignedSat(res, esize);
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

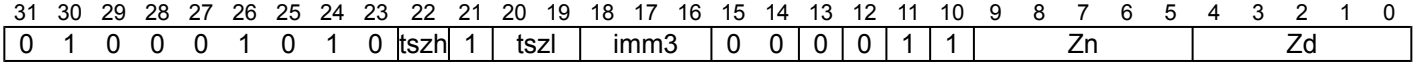
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQRSHRUNT

Signed saturating rounding shift right unsigned narrow by immediate (top).

Shift each signed integer value in the source vector elements right by an immediate value, and place the rounded results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQRSHRUNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (SInt(element) + round_const) >> shift;
    Elem[result, 2*e + 1, esize] = UnsignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

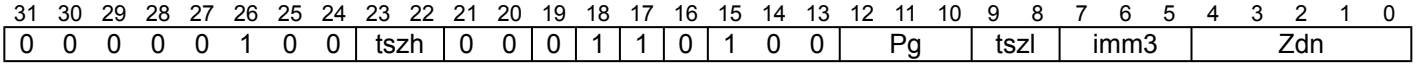
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQSHL (immediate)

Signed saturating shift left by immediate.

Shift left by immediate each active signed element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 << shift;
        Elem[result, e, esize] = SignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

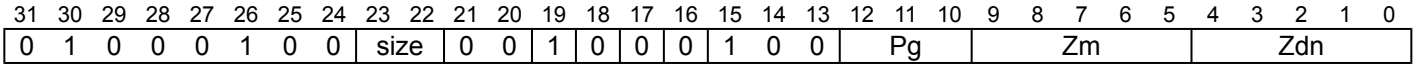
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQSHL (vectors)

Signed saturating shift left by vector (predicated).

Shift active signed elements of the first source vector by corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    if ElemP[mask, e, esize] == '1' then
        integer res = element << shift;
        Elem[result, e, esize] = SignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

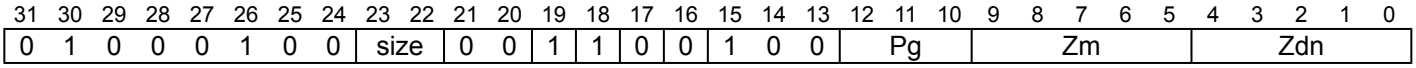
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQSHLR

Signed saturating shift left reversed vectors (predicated).

Shift active signed elements of the second source vector by corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQSHLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[m];
bits(VL) operand2 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    if ElemP[mask, e, esize] == '1' then
        integer res = element << shift;
        Elem[result, e, esize] = SignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand2, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

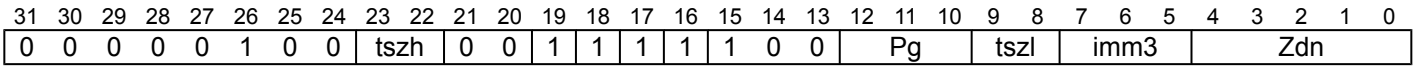
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQSHLU

Signed saturating shift left unsigned by immediate.

Shift left by immediate each active signed element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQSHLU <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 << shift;
        Elem[result, e, esize] = UnsignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

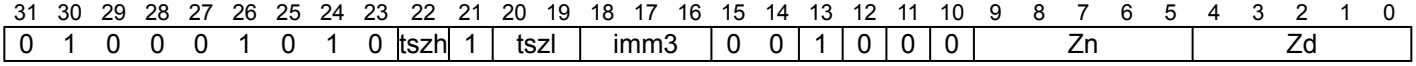
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQSHRNB

Signed saturating shift right narrow by immediate (bottom).

Shift each signed integer value in the source vector elements right by an immediate value, and place the truncated results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. Each result element is saturated to the half-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQSHRNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = SInt(element) >> shift;
    Elem[result, 2*e + 0, esize] = SignedSat(res, esize);
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

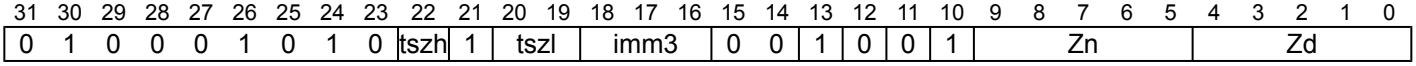
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQSHRNT

Signed saturating shift right narrow by immediate (top).

Shift each signed integer value in the source vector elements right by an immediate value, and place the truncated results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. Each result element is saturated to the half-width N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQSHRNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = SInt(element) >> shift;
    Elem[result, 2*e + 1, esize] = SignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

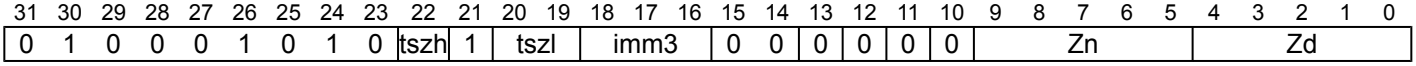
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQSHRUNB

Signed saturating shift right unsigned narrow by immediate (bottom).

Shift each signed integer value in the source vector elements right by an immediate value, and place the truncated results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQSHRUNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = SInt(element) >> shift;
    Elem[result, 2*e + 0, esize] = UnsignedSat(res, esize);
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

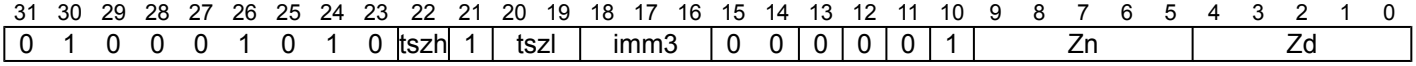
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQSHRUNT

Signed saturating shift right unsigned narrow by immediate (top).

Shift each signed integer value in the source vector elements right by an immediate value, and place the truncated results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SQSHRUNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = SInt(element) >> shift;
    Elem[result, 2*e + 1, esize] = UnsignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

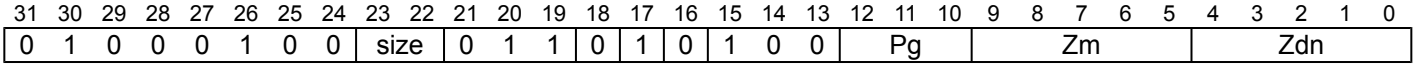
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQSUB (vectors, predicated)

Signed saturating subtraction (predicated).

Subtract active signed elements of the second source vector from corresponding signed elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQSUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = SInt(Sat(element1 - element2, esize, unsigned));
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

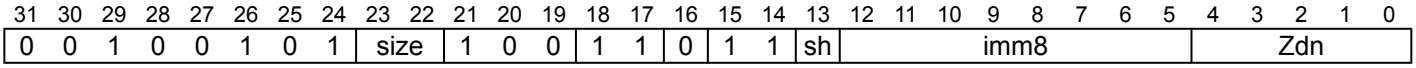
SQSUB (immediate)

Signed saturating subtract immediate (unpredicated).

Signed saturating subtract of an unsigned immediate from each element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.

The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.

The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
SQSUB <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - imm, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

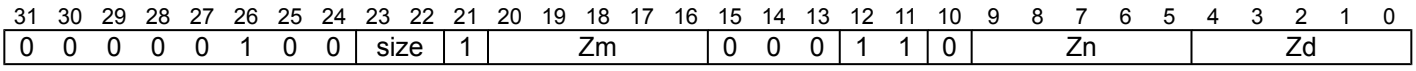
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQSUB (vectors, unpredicated)

Signed saturating subtract vectors (unpredicated).

Signed saturating subtract all elements of the second source vector from corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. This instruction is unpredicated.



SVE

```
SQSUB <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - element2, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

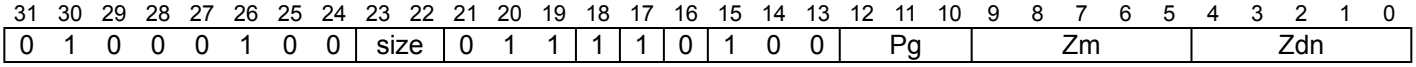
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

SQSUBR

Signed saturating subtraction reversed vectors (predicated).

Subtract active signed elements of the first source vector from corresponding signed elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SQSUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = SInt(Sat(element2 - element1, esize, unsigned));
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

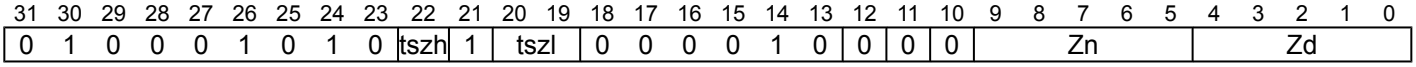
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQXTNB

Signed saturating extract narrow (bottom).

Saturate the signed integer value in each source element to half the original source element width, and place the results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero.



SVE2

```
SQXTNB <Zd>.<T>, <Zn>.<Tb>

if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '001' esize = 16;
    when '010' esize = 32;
    when '100' esize = 64;
    otherwise UNDEFINED;
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	10	H
x	11	RESERVED
1	00	S
1	01	RESERVED
1	10	RESERVED

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	10	S
x	11	RESERVED
1	00	D
1	01	RESERVED
1	10	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    bits(halfesize) res = SignedSat(element1, halfesize);
    Elem[result, 2*e + 0, halfesize] = res;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

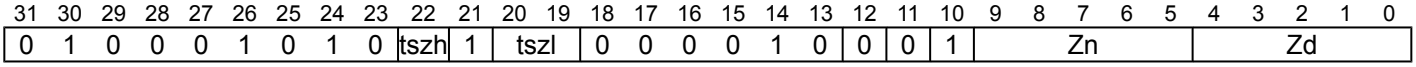
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQXTNT

Signed saturating extract narrow (top).

Saturate the signed integer value in each source element to half the original source element width, and place the results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged.



SVE2

```
SQXTNT <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '001' esize = 16;
    when '010' esize = 32;
    when '100' esize = 64;
    otherwise UNDEFINED;
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	10	H
x	11	RESERVED
1	00	S
1	01	RESERVED
1	10	RESERVED

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	10	S
x	11	RESERVED
1	00	D
1	01	RESERVED
1	10	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    bits(halfesize) res = SignedSat(element1, halfesize);
    Elem[result, 2*e + 1, halfesize] = res;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

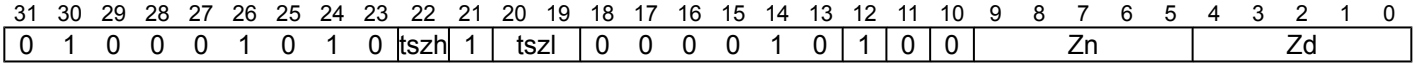
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SQXTUNB

Signed saturating unsigned extract narrow (bottom).

Saturate the signed integer value in each source element to an unsigned integer value that is half the original source element width, and place the results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero.



SVE2

```
SQXTUNB <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '001' esize = 16;
    when '010' esize = 32;
    when '100' esize = 64;
    otherwise UNDEFINED;
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	10	H
x	11	RESERVED
1	00	S
1	01	RESERVED
1	10	RESERVED

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	10	S
x	11	RESERVED
1	00	D
1	01	RESERVED
1	10	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    bits(halfesize) res = UnsignedSat(element1, halfesize);
    Elem[result, 2*e + 0, halfesize] = res;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

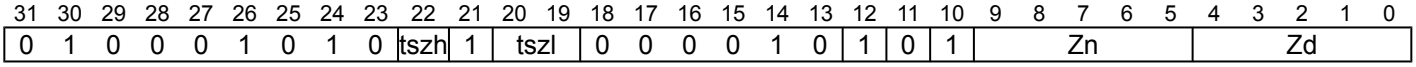
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SQXTUNT

Signed saturating unsigned extract narrow (top).

Saturate the signed integer value in each source element to an unsigned integer value that is half the original source element width, and place the results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged.



SVE2

```
SQXTUNT <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '001' esize = 16;
    when '010' esize = 32;
    when '100' esize = 64;
    otherwise UNDEFINED;
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	10	H
x	11	RESERVED
1	00	S
1	01	RESERVED
1	10	RESERVED

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	10	S
x	11	RESERVED
1	00	D
1	01	RESERVED
1	10	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    bits(halfesize) res = UnsignedSat(element1, halfesize);
    Elem[result, 2*e + 1, halfesize] = res;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

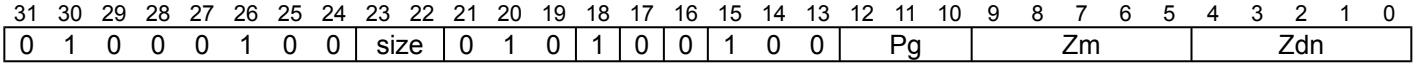
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SRHADD

Signed rounding halving addition.

Add active signed elements of the first source vector to corresponding signed elements of the second source vector, shift right one bit, and destructively place the rounded results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SRHADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer round_const = 1;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 + element2 + round_const;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

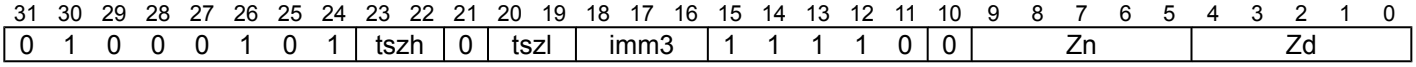
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SRI

Shift right and insert (immediate).

Shift each source vector element right by an immediate value, and insert the result into the corresponding vector element in the destination vector register, merging the shifted bits from each source element with existing bits in each destination vector element. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SRI <Zd>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element1 = Elem[result, e, esize];
    bits(esize) element2 = Elem[operand, e, esize];
    bits(esize) mask = LSR(Ones(esize), shift);
    bits(esize) shiftedval = LSR(element2, shift);
    Elem[result, e, esize] = (element1 AND (NOT mask)) OR shiftedval;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

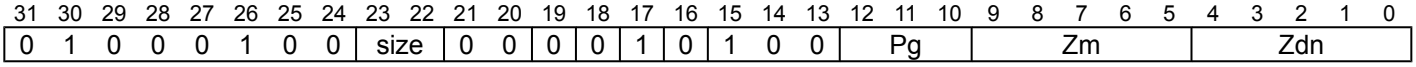
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SRSHL

Signed rounding shift left by vector (predicated).

Shift active signed elements of the first source vector by corresponding elements of the second source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SRSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

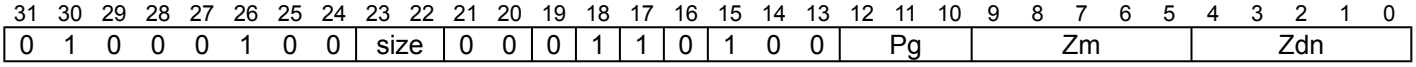
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SRSHLR

Signed rounding shift left reversed vectors (predicated).

Shift active signed elements of the second source vector by corresponding elements of the first source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SRSHLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[m];
bits(VL) operand2 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand2, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

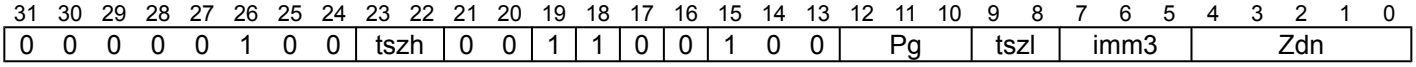
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SRSHR

Signed rounding shift right by immediate.

Shift right by immediate each active signed element of the source vector, and destructively place the rounded results in the corresponding elements of the source vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SRSHR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = (element1 + round_const) >> shift;
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

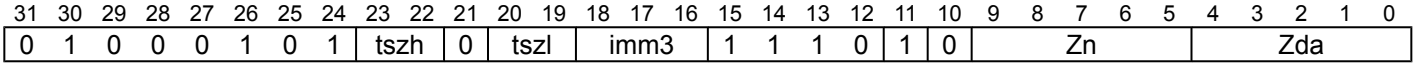
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SRSRA

Signed rounding shift right and accumulate (immediate).

Shift right by immediate each signed element of the source vector, preserving the sign bit, and add the rounded intermediate result destructively to the corresponding elements of the addend vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SRSRA <Zda>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer da = UInt(Zda);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[da];
bits(VL) result;
integer round_const = 1 << (shift - 1);

for e = 0 to elements-1
    integer element = (SInt(Elem[operand1, e, esize]) + round_const) >> shift;
    Elem[result, e, esize] = Elem[operand2, e, esize] + element<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

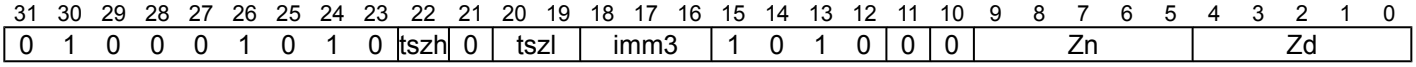
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSHLLB

Signed shift left long by immediate (bottom).

Shift left by immediate each even-numbered signed element of the source vector, and place the results in the overlapping double-width elements of the destination vector. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. This instruction is unpredicated.



SVE2

```
SSHLLB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element = Elem[operand, 2*e + 0, esize];
    integer shifted_value = SInt(element) << shift;
    Elem[result, e, 2*esize] = shifted_value<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

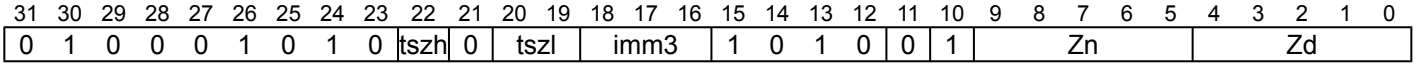
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSHLLT

Signed shift left long by immediate (top).

Shift left by immediate each odd-numbered signed element of the source vector, and place the results in the overlapping double-width elements of the destination vector. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. This instruction is unpredicated.



SVE2

```
SSHLLT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element = Elem[operand, 2*e + 1, esize];
    integer shifted_value = SInt(element) << shift;
    Elem[result, e, 2*esize] = shifted_value<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

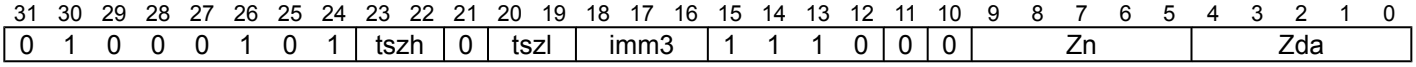
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SSRA

Signed shift right and accumulate (immediate).

Shift right by immediate each signed element of the source vector, preserving the sign bit, and add the truncated intermediate result destructively to the corresponding elements of the addend vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
SSRA <Zda>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer da = UInt(Zda);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer element = SInt(Elem[operand1, e, esize]) >> shift;
    Elem[result, e, esize] = Elem[operand2, e, esize] + element<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

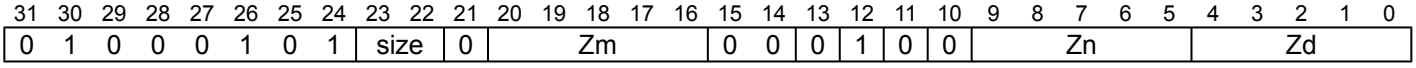
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSUBLB

Signed subtract long (bottom).

Subtract the even-numbered signed elements of the second source vector from the corresponding signed elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SSUBLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 0;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 - element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

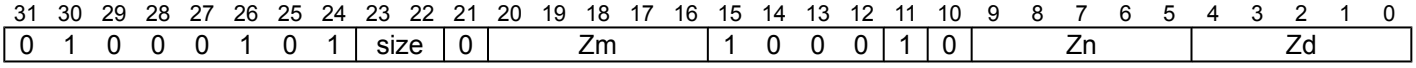
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSUBLBT

Signed subtract long (bottom - top).

Subtract the odd-numbered signed elements of the second source vector from the even-numbered signed elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SSUBLBT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 - element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

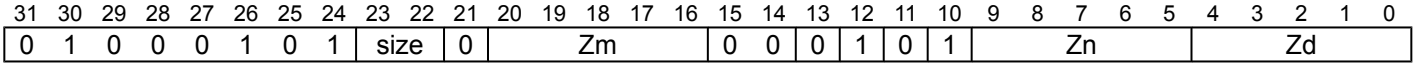
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSUBLT

Signed subtract long (top).

Subtract the odd-numbered signed elements of the second source vector from the corresponding signed elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SSUBLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 1;
integer sel2 = 1;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 - element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

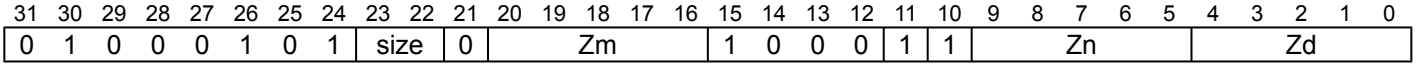
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSUBLTB

Signed subtract long (top - bottom).

Subtract the even-numbered signed elements of the second source vector from the odd-numbered signed elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SSUBLTB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 1;
integer sel2 = 0;
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 - element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

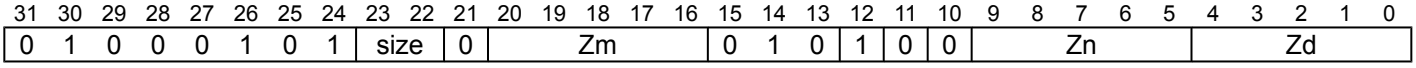
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSUBWB

Signed subtract wide (bottom).

Subtract the even-numbered signed elements of the second source vector from the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SSUBWB <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    Elem[result, e, esize] = (element1 - element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

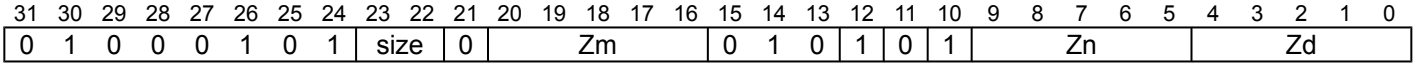
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SSUBWT

Signed subtract wide (top).

Subtract the even-numbered signed elements of the second source vector from the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
SSUBWT <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = SInt(Elem[operand1, e, esize]);
    integer element2 = SInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    Elem[result, e, esize] = (element1 - element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

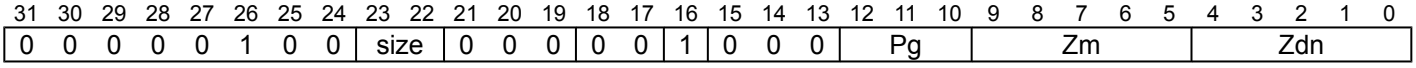
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SUB (vectors, predicated)

Subtract vectors (predicated).

Subtract active elements of the second source vector from corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element1 - element2;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

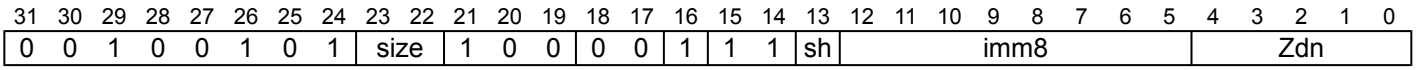
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SUB (immediate)

Subtract immediate (unpredicated).

Subtract an unsigned immediate from each element of the source vector, and destructively place the results in the corresponding elements of the source vector. This instruction is unpredicated.
The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.
The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
SUB <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    Elem[result, e, esize] = element1 - imm;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

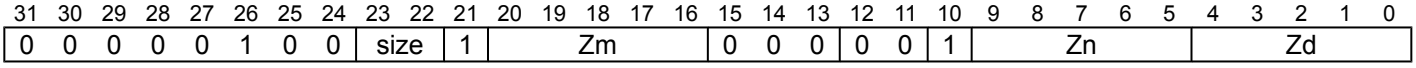
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SUB (vectors, unpredicated)

Subtract vectors (unpredicated).

Subtract all elements of the second source vector from corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE

```
SUB <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    Elem[result, e, esize] = element1 - element2;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

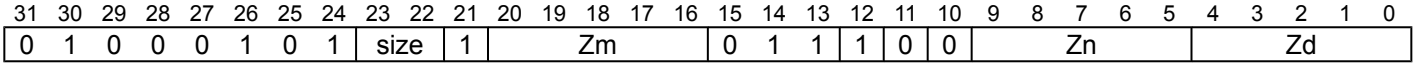
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SUBHNB

Subtract narrow high part (bottom).

Subtract each vector element of the second source vector from the corresponding vector element in the first source vector, and place the most significant half of the result in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. This instruction is unpredicated.



SVE2

```
SUBHNB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = (element1 - element2) >> halfesize;
    Elem[result, 2*e + 0, halfesize] = res<halfesize-1:0>;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

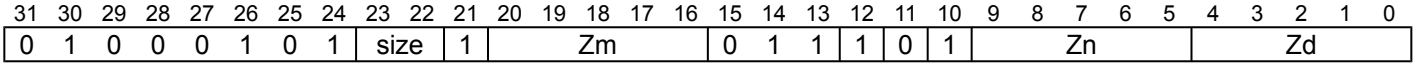
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SUBHNT

Subtract narrow high part (top).

Subtract each vector element of the second source vector from the corresponding vector element in the first source vector, and place the most significant half of the result in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. This instruction is unpredicated.



SVE2

```
SUBHNT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	B
10	H
11	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	H
10	S
11	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    integer res = (element1 - element2) >> halfesize;
    Elem[result, 2*e + 1, halfesize] = res<halfesize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

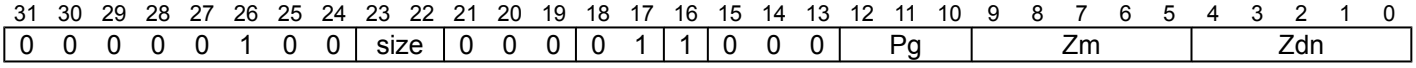
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SUBR (vectors)

Reversed subtract vectors (predicated).

Reversed subtract active elements of the first source vector from corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
SUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = element2 - element1;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

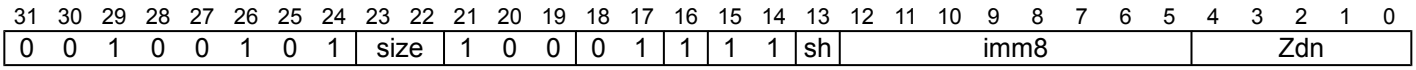
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

SUBR (immediate)

Reversed subtract from immediate (unpredicated).

Reversed subtract from an unsigned immediate each element of the source vector, and destructively place the results in the corresponding elements of the source vector. This instruction is unpredicated.
The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.
The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
SUBR <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    Elem[result, e, esize] = (imm - element1)<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

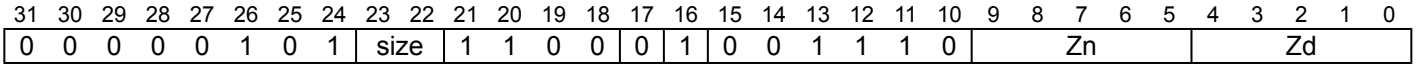
SUNPKHI, SUNPKLO

Signed unpack and extend half of vector.

Unpack elements from the lowest or highest half of the source vector and then sign-extend them to place in elements of twice their size within the destination vector. This instruction is unpredicated.

It has encodings from 2 classes: High half and Low half

High half

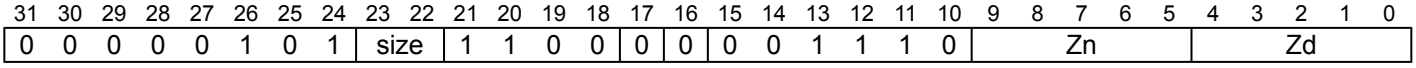


High half

```
SUNPKHI <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = FALSE;
boolean hi = TRUE;
```

Low half



Low half

```
SUNPKLO <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = FALSE;
boolean hi = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer hsize = esize DIV 2;
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(hsize) element = if hi then Elem[operand, e + elements, hsize] else Elem[operand, e, hsize];
    Elem[result, e, esize] = Extend(element, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

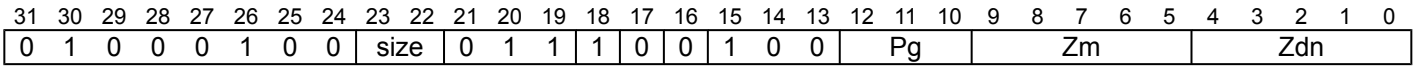
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

SUQADD

Signed saturating addition of unsigned value.

Add active unsigned elements of the source vector to the corresponding signed elements of the addend vector, and destructively place the results in the corresponding elements of the addend vector. Each result element is saturated to the N-bit element's signed integer range $-2^{(N-1)}$ to $(2^{(N-1)})-1$. Inactive elements in the destination vector register remain unmodified.



SVE2

```
SUQADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = SignedSat(SInt(element1) + UInt(element2), esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

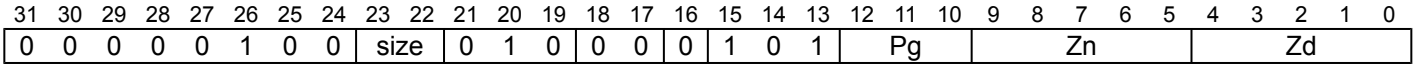
SXTB, SXTH, SXTW

Signed byte / halfword / word extend (predicated).

Sign-extend the least-significant sub-element of each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.

It has encodings from 3 classes: Byte , Halfword and Word

Byte

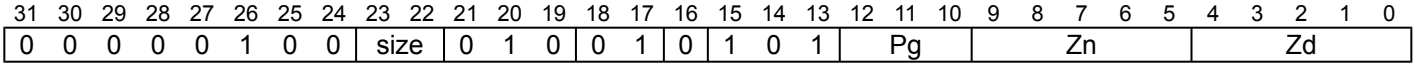


Byte

```
SXTB <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer s_esize = 8;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = FALSE;
```

Halfword

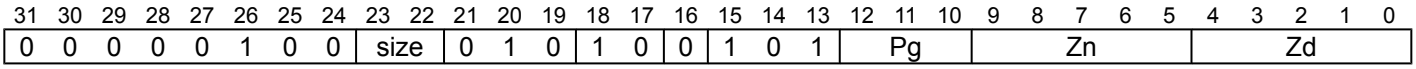


Halfword

```
SXTH <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size != '1x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer s_esize = 16;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = FALSE;
```

Word



Word

```
SXTW <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
if size != '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer s_esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> For the byte variant: is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

For the halfword variant: is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = Extend(element<s_esize-1:0>, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

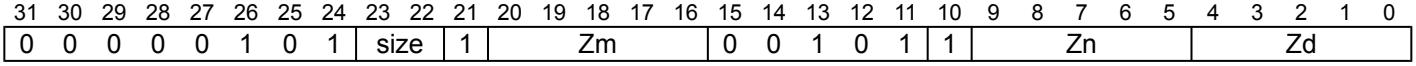
(old) htmldiff from- (new)

TBX

Programmable table lookup in single vector table (merging).

Reads each element of the second source (index) vector and uses its value to select an indexed element from a table of elements in the first source vector, and places the indexed element in the destination vector element corresponding to the index vector element. If an index value is greater than or equal to the number of vector elements then the corresponding destination vector element is left unchanged.

Since the index values can select any element in a vector this operation is not naturally vector length agnostic.



SVE2

```
TBX <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[d];

for e = 0 to elements-1
    integer element2 = UInt(Elem[operand2, e, esize]);
    if element2 < elements then
        Elem[result, e, esize] = Elem[operand1, element2, esize];

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

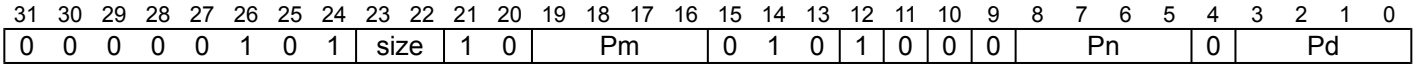
TRN1, TRN2 (predicates)

Interleave even or odd elements from two predicates.

Interleave alternating even or odd-numbered elements from the first and second source predicates and place in elements of the destination predicate. This instruction is unpredicated.

It has encodings from 2 classes: Even and Odd

Even

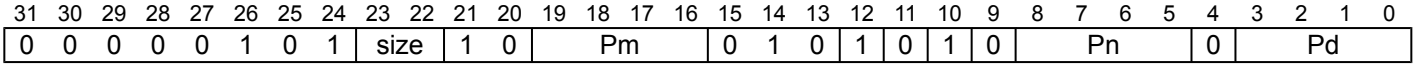


Even

```
TRN1 <Pd>.<T>, <Pn>.<T>, <Pm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
integer part = 0;
```

Odd



Odd

```
TRN2 <Pd>.<T>, <Pn>.<T>, <Pm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
integer part = 1;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pn> Is the name of the first source scalable predicate register, encoded in the "Pn" field.

<Pm> Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

for p = 0 to pairs-1
    Elem[result, 2*p+0, esize DIV 8] = Elem[operand1, 2*p+part, esize DIV 8];
    Elem[result, 2*p+1, esize DIV 8] = Elem[operand2, 2*p+part, esize DIV 8];

P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

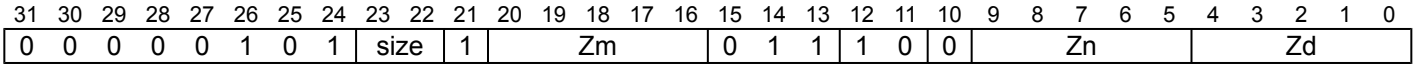
TRN1, TRN2 (vectors)

Interleave even or odd elements from two vectors.

Interleave alternating even or odd-numbered elements from the first and second source vectors and place in elements of the destination vector. This instruction is unpredicated.

It has encodings from 2 classes: Even and Odd

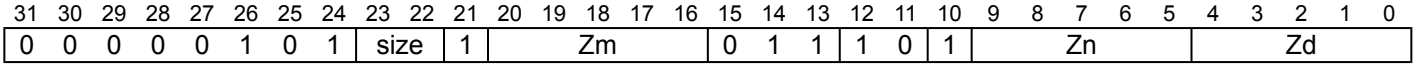
Even



Even

```
TRN1 <Zd>.<T>, <Zn>.<T>, <Zm>.<T>

if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer part = 0;
```

Odd



Odd

```
TRN2 <Zd>.<T>, <Zn>.<T>, <Zm>.<T>

if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer part = 1;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for p = 0 to pairs-1
    Elem[result, 2*p+0, esize] = Elem[operand1, 2*p+part, esize];
    Elem[result, 2*p+1, esize] = Elem[operand2, 2*p+part, esize];

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

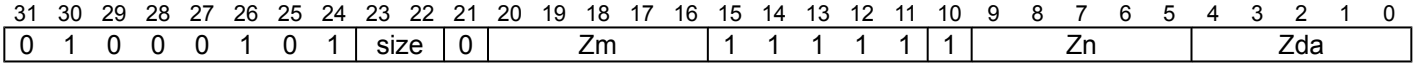
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UABA

Unsigned absolute difference and accumulate.

Compute the absolute difference between unsigned integer values in elements of the second source vector and corresponding elements of the first source vector, and add the difference to the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
UABA <Zda>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    integer element3 = Int(Elem[result, e, esize], unsigned);
    integer res = element3 + Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

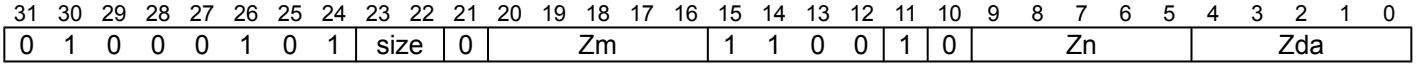
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UABALB

Unsigned absolute difference and accumulate long (bottom).

Compute the absolute difference between even-numbered unsigned elements of the second source vector and corresponding elements of the first source vector, and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
UABALB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 + Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

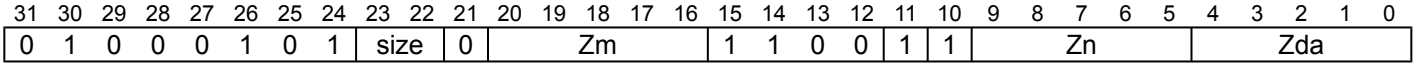
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UABALT

Unsigned absolute difference and accumulate long (top).

Compute the absolute difference between odd-numbered unsigned elements of the second source vector and corresponding elements of the first source vector, and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
UABALT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 + Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

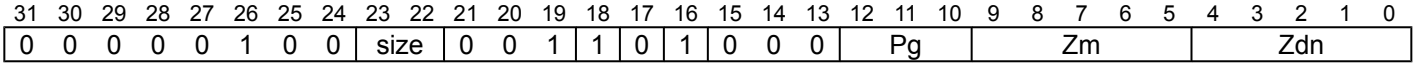
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UABD

Unsigned absolute difference (predicated).

Compute the absolute difference between unsigned integer values in active elements of the second source vector and corresponding elements of the first source vector and destructively place the difference in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
UABD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer absdiff = Abs(element1 - element2);
        Elem[result, e, esize] = absdiff<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

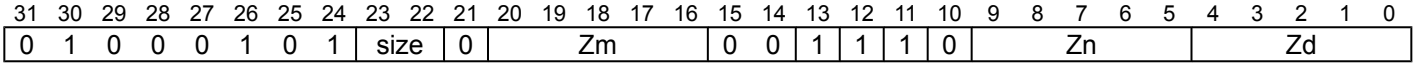
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UABDLB

Unsigned absolute difference long (bottom).

Compute the absolute difference between the even-numbered unsigned integer values in elements of the second source vector and the corresponding elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UABDLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer res = Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

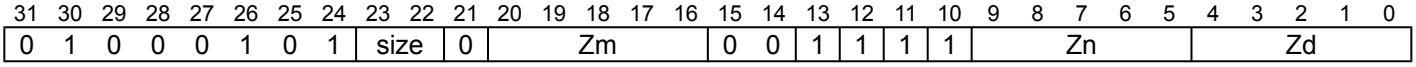
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UABDLT

Unsigned absolute difference long (top).

Compute the absolute difference between the odd-numbered unsigned integer values in elements of the second source vector and corresponding elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UABDLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer res = Abs(element1 - element2);
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

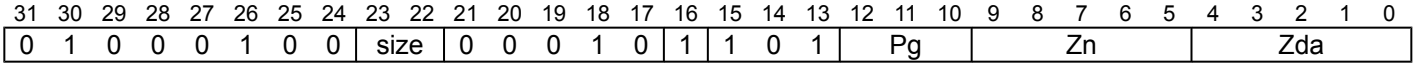
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UADALP

Unsigned add and accumulate long pairwise.

Add pairs of adjacent unsigned integer values and accumulate the results into the overlapping double-width elements of the destination vector.



SVE2

```
UADALP <Zda>.<T>, <Pg>/M, <Zn>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the second source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand_acc = Z[da];
bits(VL) operand_src = Z[n];
bits(VL) result;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand_acc, e, esize];
    else
        integer element1 = UInt(Elem[operand_src, 2*e + 0, esize DIV 2]);
        integer element2 = UInt(Elem[operand_src, 2*e + 1, esize DIV 2]);
        integer element3 = UInt(Elem[operand_acc, e, esize]);

        Elem[result, e, esize] = (element1 + element2 + element3)<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

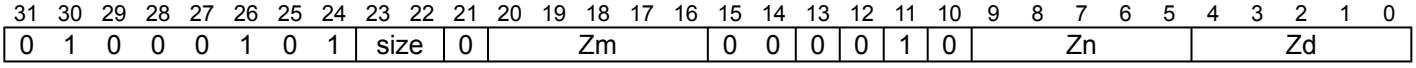
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UADDLB

Unsigned add long (bottom).

Add the corresponding even-numbered unsigned elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UADDLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 0;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 + element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

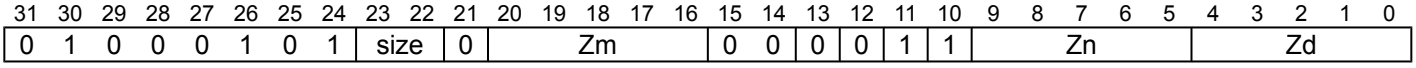
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UADDLT

Unsigned add long (top).

Add the corresponding odd-numbered unsigned elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UADDLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 1;
integer sel2 = 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 + element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

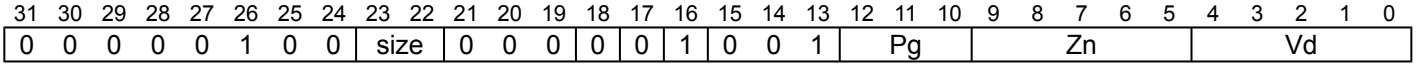
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UADDV

Unsigned add reduction to scalar.

Unsigned add horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Narrow elements are first zero-extended to 64 bits. Inactive elements in the source vector are treated as zero.



SVE

```
UADDV <Dd>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
```

Assembler Symbols

<Dd> Is the 64-bit name of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer sum = 0;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer element = UInt(Elem[operand, e, esize]);
        sum = sum + element;

V[d] = sum<63:0>;
```

Operational information

If PSTATE.DIT is 1:

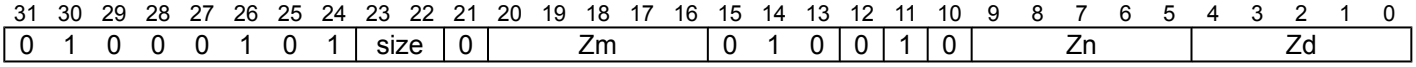
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

UADDWB

Unsigned add wide (bottom).

Add the even-numbered unsigned elements of the second source vector to the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UADDWB <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    Elem[result, e, esize] = (element1 + element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

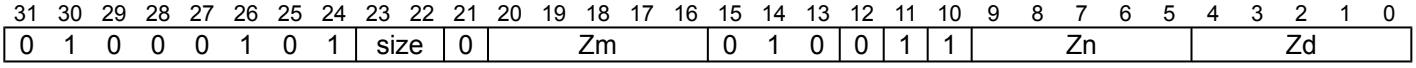
(old) htmldiff from- (new)

(old) htmldiff from- (new)

UADDWT

Unsigned add wide (top).

Add the odd-numbered unsigned elementselemenrs of the second source vector to the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UADDWT <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    Elem[result, e, esize] = (element1 + element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

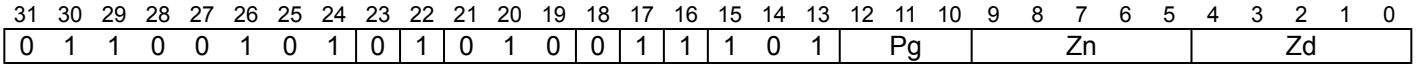
UCVTF

Unsigned integer convert to floating-point (predicated).

Convert to floating-point from the unsigned integer in each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.
If the input and result types have a different size the smaller type is held unpacked in the least significant bits of elements of the larger size. When the input is the smaller type the upper bits of each source element are ignored. When the result is the smaller type the upper bits of each destination element are set to zero.

It has encodings from 7 classes: 16-bit to half-precision , 32-bit to half-precision , 32-bit to single-precision , 32-bit to double-precision , 64-bit to half-precision , 64-bit to single-precision and 64-bit to double-precision

16-bit to half-precision

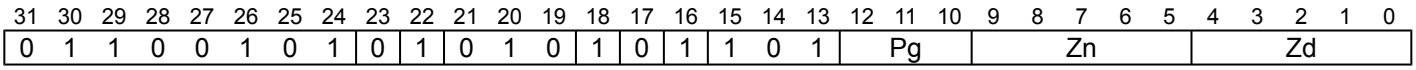


16-bit to half-precision

```
UCVTF <Zd>.H, <Pg>/M, <Zn>.H
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 16;
integer d_esize = 16;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

32-bit to half-precision

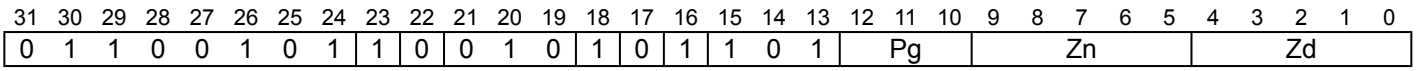


32-bit to half-precision

```
UCVTF <Zd>.H, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 16;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

32-bit to single-precision

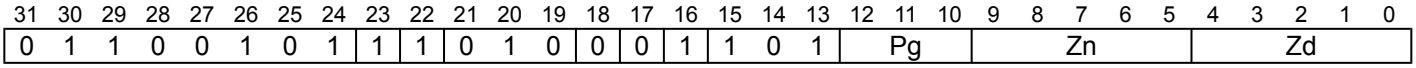


32-bit to single-precision

```
UCVTF <Zd>.S, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 32;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

32-bit to double-precision

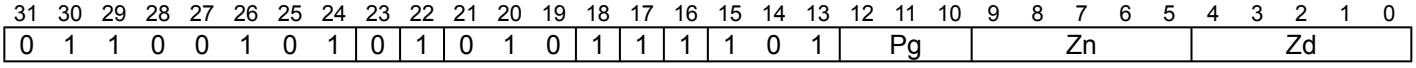


32-bit to double-precision

```
UCVTF <Zd>.D, <Pg>/M, <Zn>.S
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 32;
integer d_esize = 64;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

64-bit to half-precision

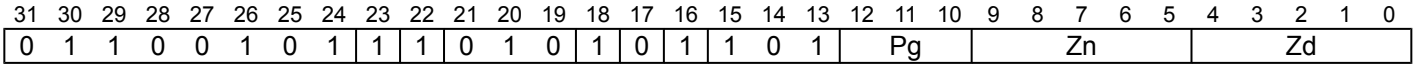


64-bit to half-precision

```
UCVTF <Zd>.H, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 16;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

64-bit to single-precision

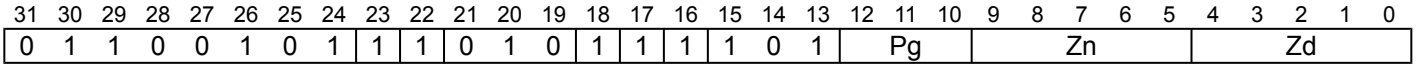


64-bit to single-precision

```
UCVTF <Zd>.S, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 32;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

64-bit to double-precision



64-bit to double-precision

```
UCVTF <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
integer s_esize = 64;
integer d_esize = 64;
boolean unsigned = TRUE;
FPRounding rounding = FPRoundingMode(FPCR);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        bits(d_esize) fpval = FixedToFP(element<s_esize-1:0>, 0, unsigned, FPCR, rounding);
        Elem[result, e, esize] = ZeroExtend(fpval);

Z[d] = result;
```

Operational information

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

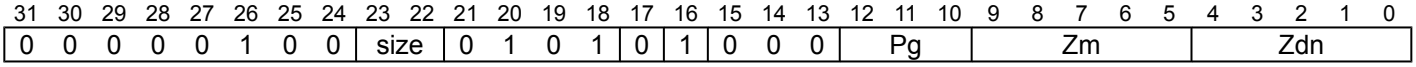
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UDIV

Unsigned divide (predicated).

Unsigned divide active elements of the first source vector by corresponding elements of the second source vector and destructively place the quotient in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
UDIV <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer quotient;
        if element2 == 0 then
            quotient = 0;
        else
            quotient = RoundTowardsZero(Real(element1) / Real(element2));
        Elem[result, e, esize] = quotient<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

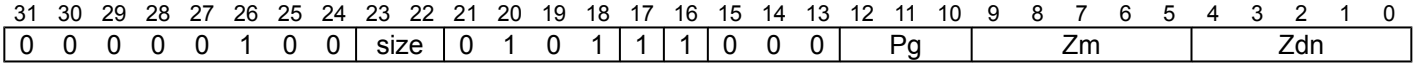
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UDIVR

Unsigned reversed divide (predicated).

Unsigned reversed divide active elements of the second source vector by corresponding elements of the first source vector and destructively place the quotient in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
UDIVR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer quotient;
        if element1 == 0 then
            quotient = 0;
        else
            quotient = RoundTowardsZero(Real(element2) / Real(element1));
        Elem[result, e, esize] = quotient<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

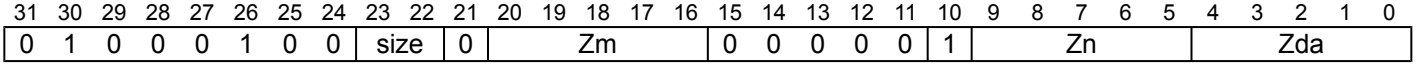
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UDOT (vectors)

Unsigned dot product.

The unsigned integer partial dot product instruction delimits the source vectors into quadtuplets of four 8-bit or 16-bit unsigned integer elements. Within each quadtuplet the elements in the first source vector are multiplied by the corresponding elements in the second source vector and the resulting widened products are summed and added to the 32-bit or 64-bit element of the accumulator and destination vector which aligns with the quadtuplet in the first source vector.



SVE

```
UDOT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE() then UNDEFINED;
if size == '0x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size<0>”:

size<0>	<Tb>
0	B
1	H

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) res = Elem[operand3, e, esize];
    for i = 0 to 3
        integer element1 = UInt(Elem[operand1, 4 * e + i, esize DIV 4]);
        integer element2 = UInt(Elem[operand2, 4 * e + i, esize DIV 4]);
        res = res + element1 * element2;
    Elem[result, e, esize] = res;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UDOT (indexed)

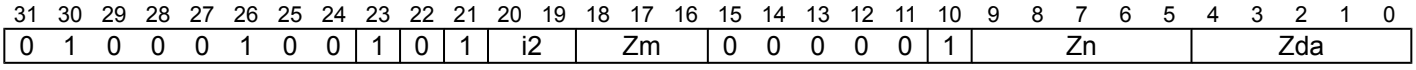
Unsigned dot product by indexed quadtuplet.

The indexed unsigned integer partial dot product instruction delimits the source vectors into quadtuplets of four 8-bit or 16-bit unsigned integer elements. Within each quadtuplet of each 128-bit vector segment the elements in the first source vector are multiplied by the corresponding elements in the specified quadtuplet of the second source vector segment and the resulting widened products are summed and added to the 32-bit or 64-bit element of the accumulator and destination vector which aligns with the quadtuplet in the first source vector.

The quadtuplets within the second source vector are specified using an immediate index which selects the same quadtuplet position within each 128-bit vector segment. The index range is from 0 to one less than the number of quadtuplets per 128-bit segment, encoded in 1 to 2 bits depending on the size of the quadtuplet.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

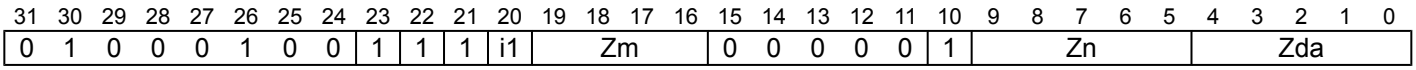


32-bit

```
UDOT <Zda>.S, <Zn>.B, <Zm>.B[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

64-bit



64-bit

```
UDOT <Zda>.D, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer index = UInt(i1);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field. For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the immediate index of a quadtuplet of four 8-bit elements within each 128-bit vector segment, in the range 0 to 3, encoded in the "i2" field. For the 64-bit variant: is the immediate index of a quadtuplet of four 16-bit elements within each 128-bit vector segment, in the range 0 to 1, encoded in the "i1" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer eltspersegment = 128 DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) operand3 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer segmentbase = e - e MOD eltspersegment;
    integer s = segmentbase + index;
    bits(esize) res = Elem[operand3, e, esize];
    for i = 0 to 3
        integer element1 = UInt(Elem[operand1, 4 * e + i, esize DIV 4]);
        integer element2 = UInt(Elem[operand2, 4 * s + i, esize DIV 4]);
        res = res + element1 * element2;
    Elem[result, e, esize] = res;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

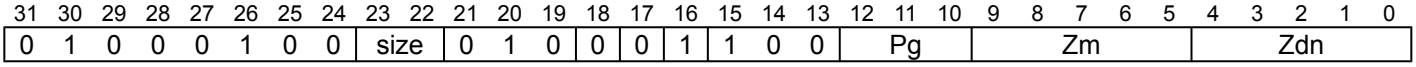
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UHADD

Unsigned halving addition.

Add active unsigned elements of the first source vector to corresponding unsigned elements of the second source vector, shift right one bit, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UHADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 + element2;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

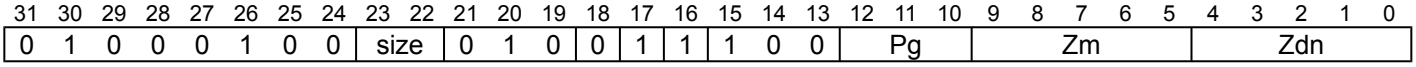
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UHSUB

Unsigned halving subtract.

Subtract active unsigned elements of the second source vector from corresponding unsigned elements of the first source vector, shift right one bit, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UHSUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 - element2;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

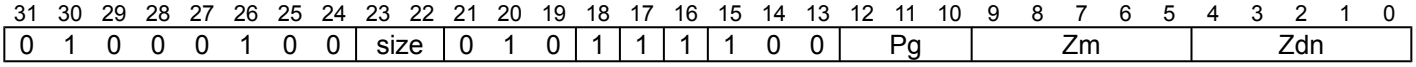
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UHSUBR

Unsigned halving subtract reversed vectors.

Subtract active unsigned elements of the first source vector from corresponding unsigned elements of the second source vector, shift right one bit, and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UHSUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element2 - element1;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

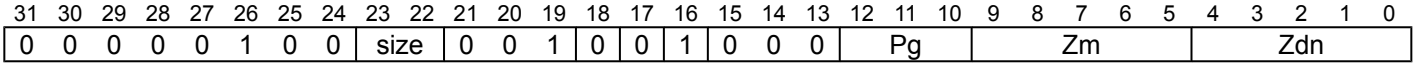
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMAX (vectors)

Unsigned maximum vectors (predicated).

Determine the unsigned maximum of active elements of the second source vector and corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
UMAX <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer maximum = Max(element1, element2);
        Elem[result, e, esize] = maximum<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

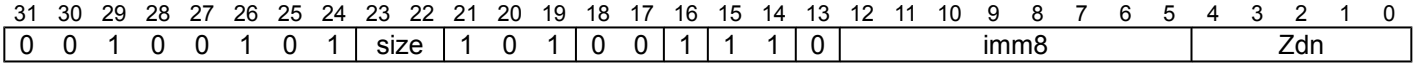
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UMAX (immediate)

Unsigned maximum with immediate (unpredicated).

Determine the unsigned maximum of an immediate and each element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is an unsigned 8-bit value in the range 0 to 255, inclusive. This instruction is unpredicated.



SVE

```
UMAX <Zdn>.<T>, <Zdn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
boolean unsigned = TRUE;
integer imm = Int(imm8, unsigned);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is the unsigned immediate operand, in the range 0 to 255, encoded in the "imm8" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    Elem[result, e, esize] = Max(element1, imm)<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

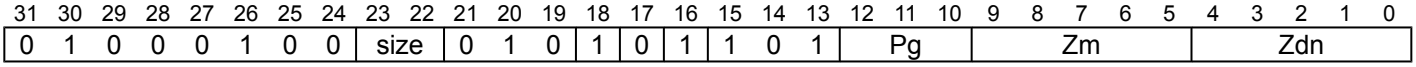
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMAXP

Unsigned maximum pairwise.

Compute the maximum value of each pair of adjacent unsigned integer elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
UMAXP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer element1;
integer element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand1, e, esize];
    else
        if IsEven(e) then
            element1 = UInt(Elem[operand1, e + 0, esize]);
            element2 = UInt(Elem[operand1, e + 1, esize]);
        else
            element1 = UInt(Elem[operand2, e - 1, esize]);
            element2 = UInt(Elem[operand2, e + 0, esize]);
        integer res = Max(element1, element2);
        Elem[result, e, esize] = res<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

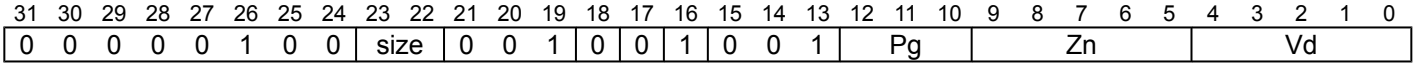
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UMAXV

Unsigned maximum reduction to scalar.

Unsigned maximum horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as zero.



SVE

```
UMAXV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
boolean unsigned = TRUE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer maximum = if unsigned then 0 else -(2^(esize-1));

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer element = Int(Elem[operand, e, esize], unsigned);
        maximum = Max(maximum, element);

V[d] = maximum<esize-1:0>;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

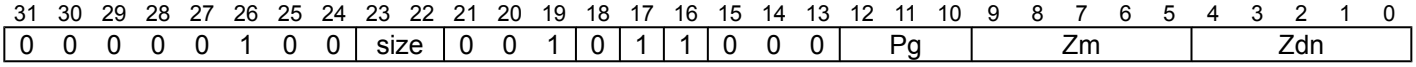
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMIN (vectors)

Unsigned minimum vectors (predicated).

Determine the unsigned minimum of active elements of the second source vector and corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
UMIN <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer minimum = Min(element1, element2);
        Elem[result, e, esize] = minimum<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

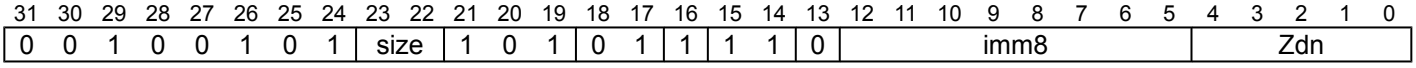
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMIN (immediate)

Unsigned minimum with immediate (unpredicated).

Determine the unsigned minimum of an immediate and each element of the source vector, and destructively place the results in the corresponding elements of the source vector. The immediate is an unsigned 8-bit value in the range 0 to 255, inclusive. This instruction is unpredicated.



SVE

```
UMIN <Zdn>.<T>, <Zdn>.<T>, #<imm>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
boolean unsigned = TRUE;
integer imm = Int(imm8, unsigned);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is the unsigned immediate operand, in the range 0 to 255, encoded in the "imm8" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    Elem[result, e, esize] = Min(element1, imm)<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

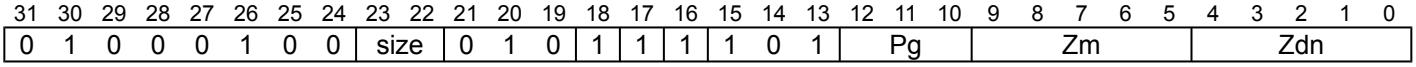
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMINP

Unsigned minimum pairwise.

Compute the minimum value of each pair of adjacent unsigned integer elements within each source vector, and interleave the results from corresponding lanes. The interleaved result values are destructively placed in the first source vector.



SVE2

```
UMINP <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer element1;
integer element2;

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '0' then
        Elem[result, e, esize] = Elem[operand1, e, esize];
    else
        if IsEven(e) then
            element1 = UInt(Elem[operand1, e + 0, esize]);
            element2 = UInt(Elem[operand1, e + 1, esize]);
        else
            element1 = UInt(Elem[operand2, e - 1, esize]);
            element2 = UInt(Elem[operand2, e + 0, esize]);
        integer res = Min(element1, element2);
        Elem[result, e, esize] = res<esize-1:0>;

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

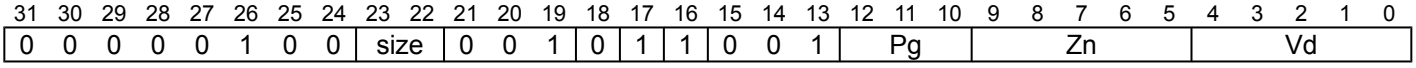
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UMINV

Unsigned minimum reduction to scalar.

Unsigned minimum horizontally across all lanes of a vector, and place the result in the SIMD&FP scalar destination register. Inactive elements in the source vector are treated as the maximum unsigned integer for the element size.



SVE

```
UMINV <V><d>, <Pg>, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Vd);
boolean unsigned = TRUE;
```

Assembler Symbols

<V> Is a width specifier, encoded in “size”:

size	<V>
00	B
01	H
10	S
11	D

<d> Is the number [0-31] of the destination SIMD&FP register, encoded in the "Vd" field.

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand = Z[n];
integer minimum = if unsigned then (2^esize - 1) else (2^(esize-1) - 1);

for e = 0 to elements-1
    if ElemP[mask, e, esize] == '1' then
        integer element = Int(Elem[operand, e, esize], unsigned);
        minimum = Min(minimum, element);

V[d] = minimum<esize-1:0>;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

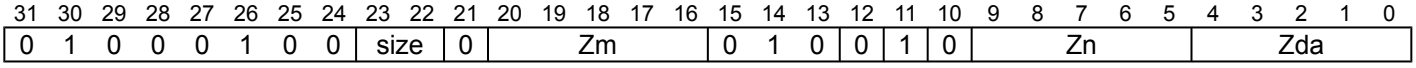
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UMLALB (vectors)

Unsigned multiply-add long to accumulator (bottom).

Multiply the corresponding even-numbered unsigned elements of the first and second source vectors and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
UMLALB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

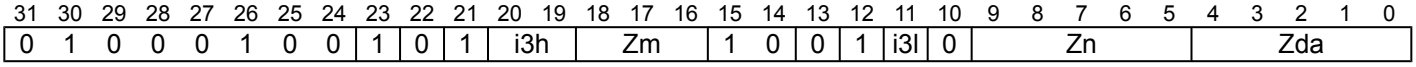
UMLALB (indexed)

Unsigned multiply-add long to accumulator (bottom, indexed).

Multiply the even-numbered unsigned elements within each 128-bit segment of the first source vector by the specified unsigned element in the corresponding second source vector segment and destructively add to the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

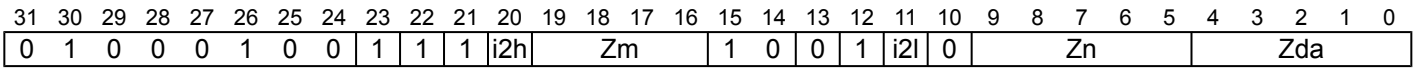


32-bit

```
UMLALB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

64-bit



64-bit

```
UMLALB <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = UInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = UInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = UInt(Elem[result, e, 2*esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

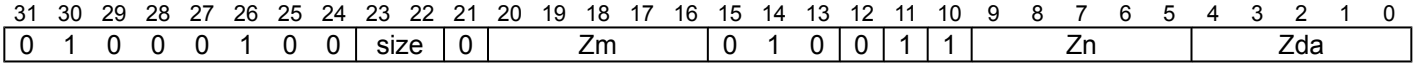
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMLALT (vectors)

Unsigned multiply-add long to accumulator (top).

Multiply the corresponding odd-numbered unsigned elements of the first and second source vectors and destructively add to the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
UMLALT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

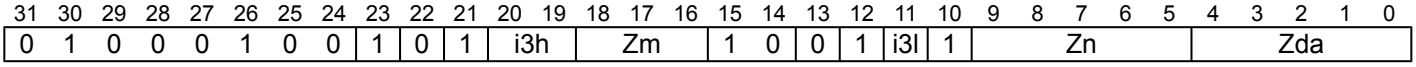
UMLALT (indexed)

Unsigned multiply-add long to accumulator (top, indexed).

Multiply the odd-numbered unsigned elements within each 128-bit segment of the first source vector by the specified unsigned element in the corresponding second source vector segment and destructively add to the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

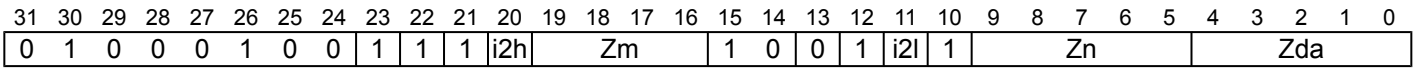


32-bit

```
UMLALT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

64-bit



64-bit

```
UMLALT <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = UInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = UInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = UInt(Elem[result, e, 2*esize]);
    integer res = element3 + element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

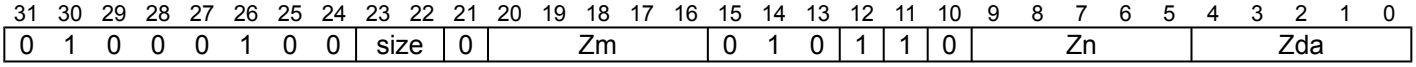
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMLSLB (vectors)

Unsigned multiply-subtract long from accumulator (bottom).

Multiply the corresponding even-numbered unsigned elements of the first and second source vectors and destructively subtract from the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
UMLSLB <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

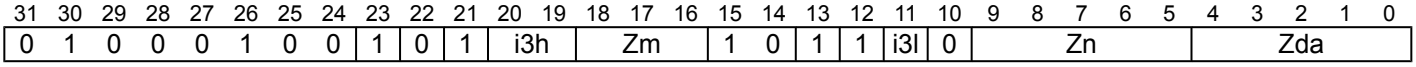
UMLSLB (indexed)

Unsigned multiply-subtract long from accumulator (bottom, indexed).

Multiply the even-numbered unsigned elements within each 128-bit segment of the first source vector by the specified unsigned element in the corresponding second source vector segment and destructively subtract from the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

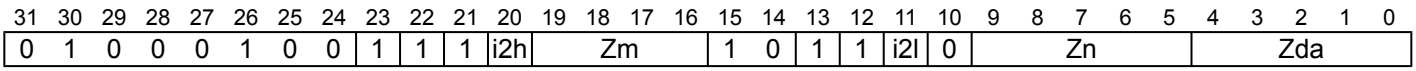
32-bit



32-bit

```
UMLSLB <Zda>.S, <Zn>.H, <Zm>.H[<imm>]

if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

64-bit



64-bit

```
UMLSLB <Zda>.D, <Zn>.S, <Zm>.S[<imm>]

if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 0;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = UInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = UInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = UInt(Elem[result, e, 2*esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

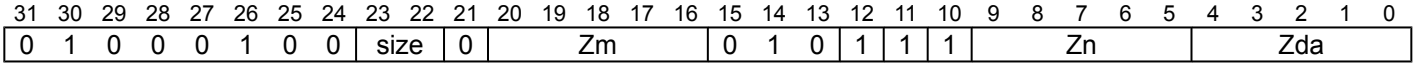
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMLSLT (vectors)

Unsigned multiply-subtract long from accumulator (top).

Multiply the corresponding odd-numbered unsigned elements of the first and second source vectors and destructively subtract from the overlapping double-width elements of the addend vector. This instruction is unpredicated.



SVE2

```
UMLSLT <Zda>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer element3 = UInt(Elem[result, e, esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

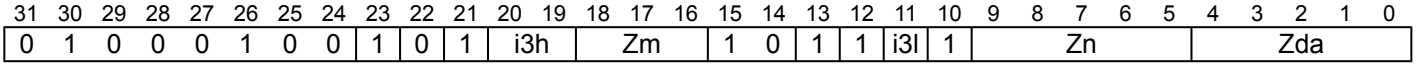
UMLSLT (indexed)

Unsigned multiply-subtract long from accumulator (top, indexed).

Multiply the odd-numbered unsigned elements within each 128-bit segment of the first source vector by the specified unsigned element in the corresponding second source vector segment and destructively subtract from the overlapping double-width elements of the addend vector.
The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

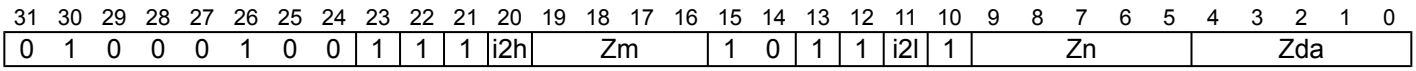


32-bit

```
UMLSLT <Zda>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

64-bit



64-bit

```
UMLSLT <Zda>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer da = UInt(Zda);
integer sel = 1;
```

Assembler Symbols

<Zda>	Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result = Z[da];

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = UInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = UInt(Elem[operand2, 2 * s + index, esize]);
    integer element3 = UInt(Elem[result, e, 2*esize]);
    integer res = element3 - element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

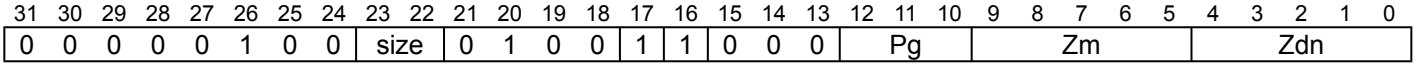
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMULH (predicated)

Unsigned multiply returning high half (predicated).

Widening multiply unsigned integer values in active elements of the first source vector by corresponding elements of the second source vector and destructively place the high half of the result in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE

```
UMULH <Zdn>.<T>, <Pg>/M, <Zdn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    if ElemP[mask, e, esize] == '1' then
        integer product = (element1 * element2) >> esize;
        Elem[result, e, esize] = product<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

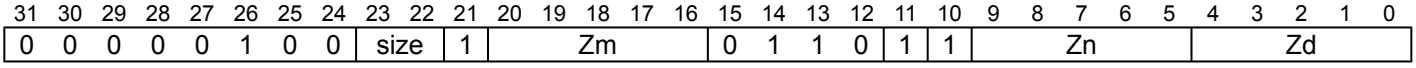
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UMULH (unpredicated)

Unsigned multiply returning high half (unpredicated).

Widening multiply unsigned integer values of all elements of the first source vector by corresponding elements of the second source vector and place the high half of the result in the corresponding elements of the destination vector. This instruction is unpredicated.



SVE2

```
UMULH <Zd>.<T>, <Zn>.<T>, <Zm>.<T>

if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    integer product = (element1 * element2) >> esize;
    Elem[result, e, esize] = product<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

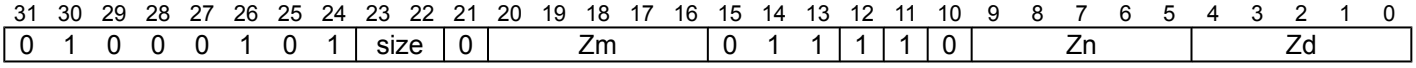
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

UMULLB (vectors)

Unsigned multiply long (bottom).

Multiply the corresponding even-numbered unsigned elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UMULLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 0, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    integer res = element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

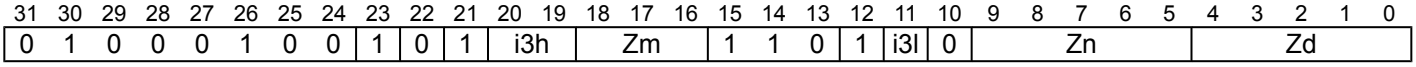
UMULLB (indexed)

Unsigned multiply long (bottom, indexed).

Multiply the even-numbered unsigned elements within each 128-bit segment of the first source vector by the specified unsigned element in the corresponding second source vector segment, and place the results in the overlapping double-width elements of the destination vector register. The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

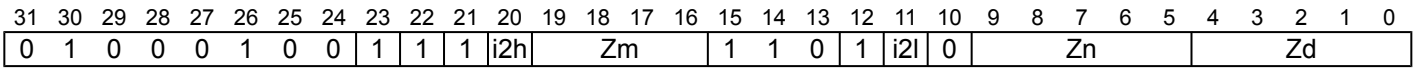


32-bit

```
UMULLB <Zd>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 0;
```

64-bit



64-bit

```
UMULLB <Zd>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 0;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = UInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = UInt(Elem[operand2, 2 * s + index, esize]);
    integer res = element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

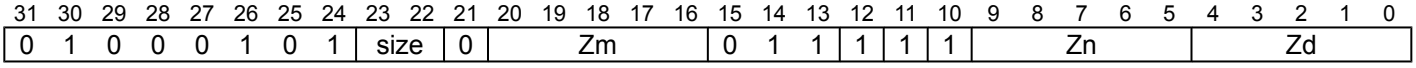
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UMULLT (vectors)

Unsigned multiply long (top).

Multiply the corresponding odd-numbered unsigned elements of the first and second source vectors, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
UMULLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, 2*e + 1, esize DIV 2]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    integer res = element1 * element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

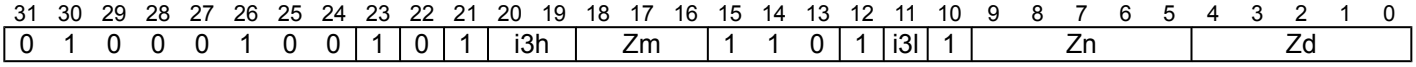
UMULLT (indexed)

Unsigned multiply long (top, indexed).

Multiply the odd-numbered unsigned elements within each 128-bit segment of the first source vector by the specified unsigned element in the corresponding second source vector segment, and place the results in the overlapping double-width elements of the destination vector register. The elements within the second source vector are specified using an immediate index which selects the same element position within each 128-bit vector segment. The index range is from 0 to one less than the number of elements per 128-bit segment, encoded in 2 or 3 bits depending on the size of the element.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

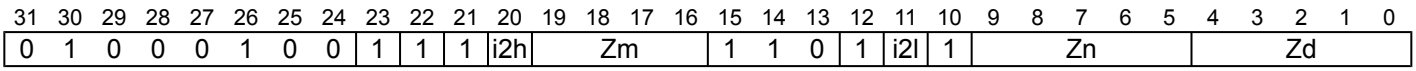


32-bit

```
UMULLT <Zd>.S, <Zn>.H, <Zm>.H[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 16;
integer index = UInt(i3h:i3l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 1;
```

64-bit



64-bit

```
UMULLT <Zd>.D, <Zn>.S, <Zm>.S[<imm>]
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 32;
integer index = UInt(i2h:i2l);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel = 1;
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Zn>	Is the name of the first source scalable vector register, encoded in the "Zn" field.
<Zm>	For the 32-bit variant: is the name of the second source scalable vector register Z0-Z7, encoded in the "Zm" field.
	For the 64-bit variant: is the name of the second source scalable vector register Z0-Z15, encoded in the "Zm" field.
<imm>	For the 32-bit variant: is the element index, in the range 0 to 7, encoded in the "i3h:i3l" fields.
	For the 64-bit variant: is the element index, in the range 0 to 3, encoded in the "i2h:i2l" fields.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
integer eltspersegment = 128 DIV (2 * esize);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer s = e - e MOD eltspersegment;
    integer element1 = UInt(Elem[operand1, 2 * e + sel,   esize]);
    integer element2 = UInt(Elem[operand2, 2 * s + index, esize]);
    integer res = element1 * element2;
    Elem[result, e, 2*esize] = res<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

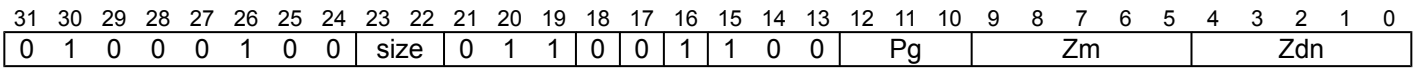
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UQADD (vectors, predicated)

Unsigned saturating addition (predicated).

Add active unsigned elements of the first source vector to corresponding unsigned elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = UInt(Sat(element1 + element2, esize, unsigned));
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

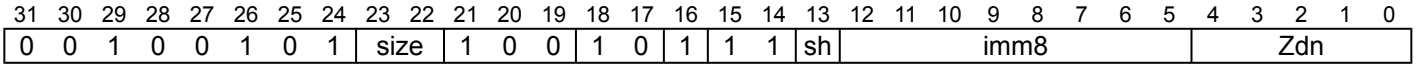
UQADD (immediate)

Unsigned saturating add immediate (unpredicated).

Unsigned saturating add of an unsigned immediate to each element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. This instruction is unpredicated.

The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.

The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
UQADD <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + imm, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

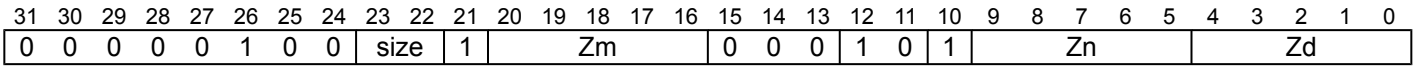
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQADD (vectors, unpredicated)

Unsigned saturating add vectors (unpredicated).

Unsigned saturating add all elements of the second source vector to corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. This instruction is unpredicated.



SVE

```
UQADD <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + element2, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

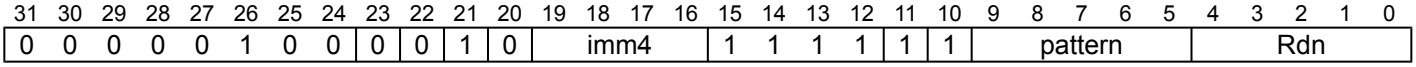
UQDECB

Unsigned saturating decrement scalar by multiple of 8-bit predicate constraint element count.

Determines the number of active 8-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

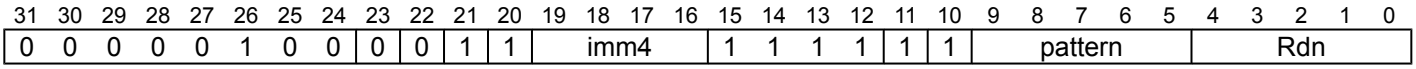
32-bit



32-bit

```
UQDECB <Wdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQDECB <Xdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

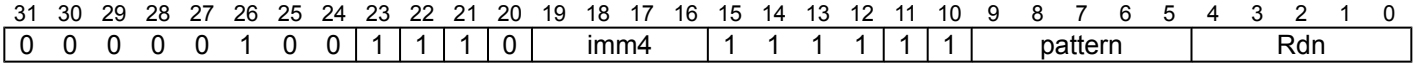
UQDECD (scalar)

Unsigned saturating decrement scalar by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

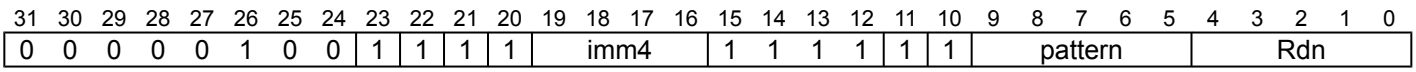


32-bit

```
UQDECD <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQDECD <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

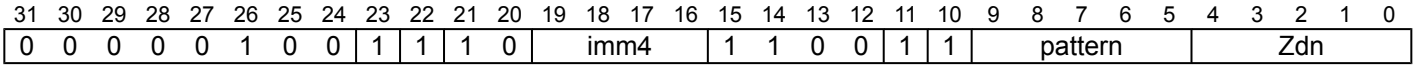
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQDECD (vector)

Unsigned saturating decrement vector by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements. The results are saturated to the 64-bit unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
UQDECD <Zdn>.D{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

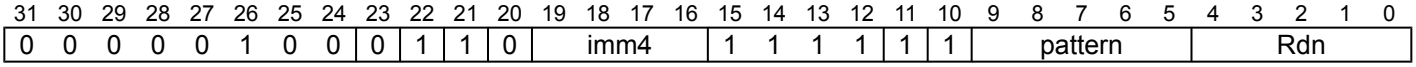
UQDECH (scalar)

Unsigned saturating decrement scalar by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

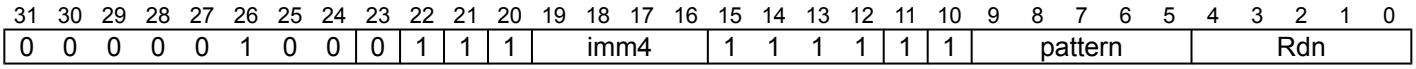


32-bit

```
UQDECH <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQDECH <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

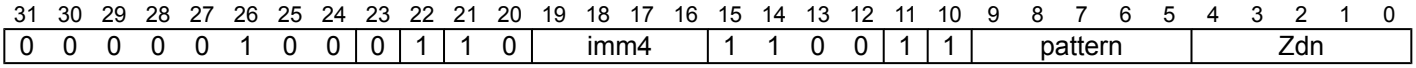
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQDECH (vector)

Unsigned saturating decrement vector by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements. The results are saturated to the 16-bit unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
UQDECH <Zdn>.H{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

(old) htmldiff from- (new)

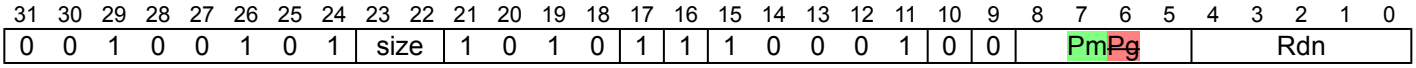
UQDECP (scalar)

Unsigned saturating decrement scalar by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to decrement the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.

It has encodings from 2 classes: 32-bit and 64-bit

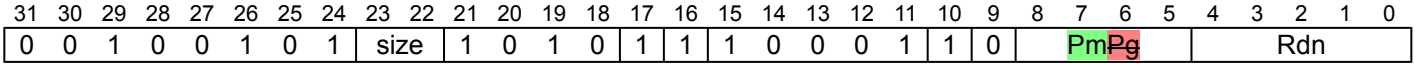
32-bit



32-bit

```
UQDECP <Wdn>, <Pm><Pg>.<T>

if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQDECP <Xdn>, <Pm><Pg>.<T>

if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(ssize) operand1 =bits(PL) mask = P[g];
bits(ssize) operand = X[dn];
bits(PL) operand2 = P[m];
[dn];
bits(ssize) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

integer element = Int(operand1, unsigned);
(operand, unsigned);
(result, -) = SatQ(element - count, ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

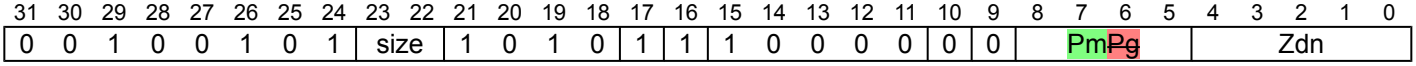
(old) htmldiff from- (new)

(old) htmldiff from- (new)

UQDECP (vector)

Unsigned saturating decrement vector by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to decrement all destination vector elements. The results are saturated to the element unsigned integer range.
The predicate size specifier may be omitted in assembler source code, but this is deprecated and will be prohibited in a future release of the architecture.



SVE

```
UQDECP <Zdn>.<T>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Zdn);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 =bits(PL) mask = P[g];
bits(VL) operand = Z[dn];
bits(PL) operand2 = P[m];
[dn];
bits(VL) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

for e = 0 to elements-1
    integer element = Int(Elem[operand1, e, esize], unsigned);
[operand, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element - count, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

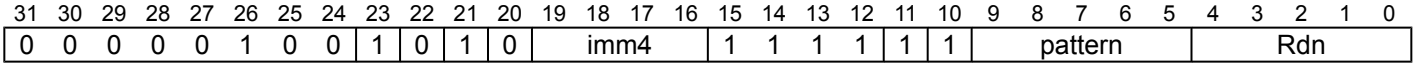
UQDECW (scalar)

Unsigned saturating decrement scalar by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

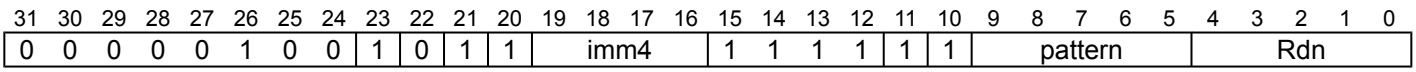
32-bit



32-bit

```
UQDECW <Wdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQDECW <Xdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 - (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

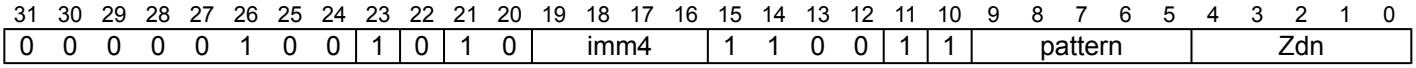
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQDECW (vector)

Unsigned saturating decrement vector by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to decrement all destination vector elements. The results are saturated to the 32-bit unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
UQDECW <Zdn>.S{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

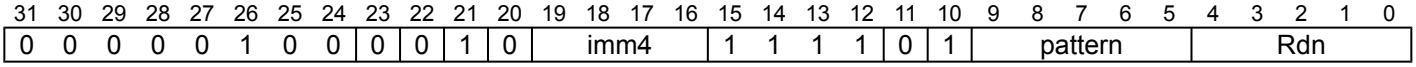
UQINCB

Unsigned saturating increment scalar by multiple of 8-bit predicate constraint element count.

Determines the number of active 8-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

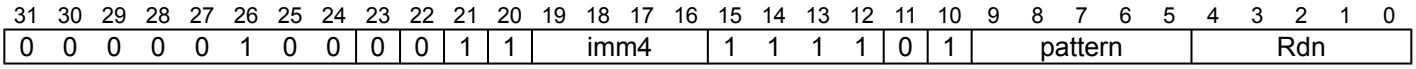
32-bit



32-bit

```
UQINCB <Wdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQINCB <Xdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 8;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

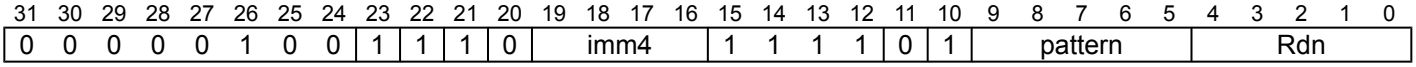
UQINCD (scalar)

Unsigned saturating increment scalar by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

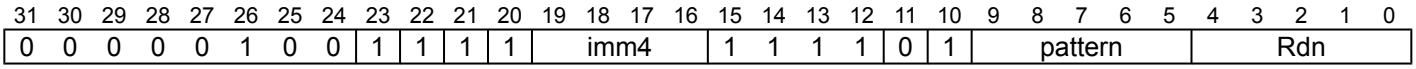
32-bit



32-bit

```
UQINCD <Wdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQINCD <Xdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

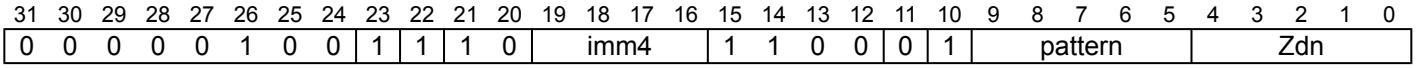
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQINCD (vector)

Unsigned saturating increment vector by multiple of 64-bit predicate constraint element count.

Determines the number of active 64-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements. The results are saturated to the 64-bit unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
UQINCD <Zdn>.D{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 64;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

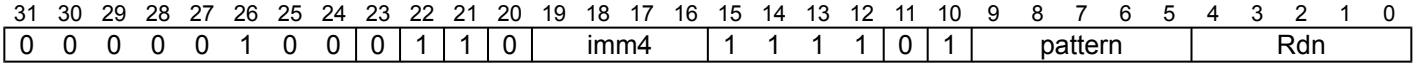
UQINCH (scalar)

Unsigned saturating increment scalar by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

32-bit

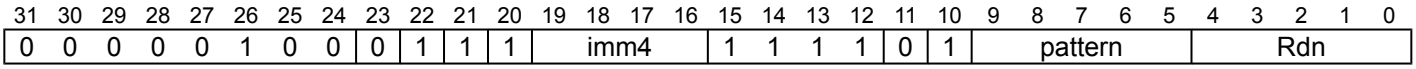


32-bit

```
UQINCH <Wdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQINCH <Xdn>{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

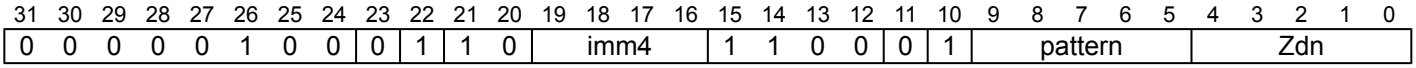
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQINCH (vector)

Unsigned saturating increment vector by multiple of 16-bit predicate constraint element count.

Determines the number of active 16-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements. The results are saturated to the 16-bit unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
UQINCH <Zdn>.H{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 16;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

(old) htmldiff from- (new)

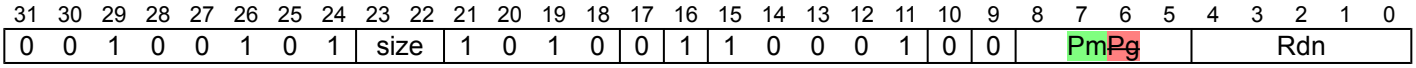
UQINCP (scalar)

Unsigned saturating increment scalar by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to increment the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.

It has encodings from 2 classes: 32-bit and 64-bit

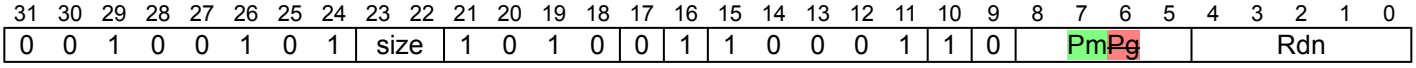
32-bit



32-bit

```
UQINCP <Wdn>, <Pm><Pg>.<T>

if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQINCP <Xdn>, <Pm><Pg>.<T>

if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Rdn);
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn> Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<Xdn> Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(ssize) operand1 =bits(PL) mask = P[g];
bits(ssize) operand = X[dn];
bits(PL) operand2 = P[m];
[dn];
bits(ssize) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

integer element = Int(operand1, unsigned);
(operand, unsigned);
(result, -) = SatQ(element + count, ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

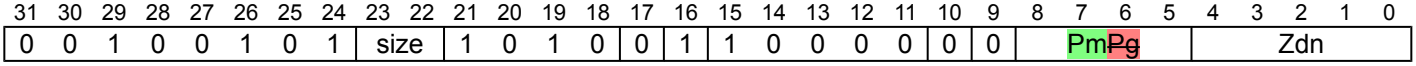
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44v30.42, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2future-20190403, sve v2019-06_rc4v8.5-00bet10_rc5 ; Build timestamp: 2019-06-26T222019-04-17T09:0458

UQINCP (vector)

Unsigned saturating increment vector by countactive ofpredicate truelement predicate elements.count.

Counts the number of trueactive elements in the source predicate and then uses the result to increment all destination vector elements. The results are saturated to the element unsigned integer range.
The predicate size specifier may be omitted in assembler source code, but this is deprecated and will be prohibited in a future release of the architecture.



SVE

```
UQINCP <Zdn>.<T>, <Pm><Pg>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer m =integer g = UInt(Pm);
(Pg);
integer dn = UInt(Zdn);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<PmPg> Is the name of the sourcegoverning scalable predicate register, encoded in the "PmPg" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 =bits(PL) mask = P[g];
bits(VL) operand = Z[dn];
bits(PL) operand2 = P[m];
[dn];
bits(VL) result;
integer count = 0;

for e = 0 to elements-1
    if ElemP[operand2, e, esize] == '1' then
[mask, e, esize] == '1' then
        count = count + 1;

for e = 0 to elements-1
    integer element = Int(Elem[operand1, e, esize], unsigned);
[operand, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element + count, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

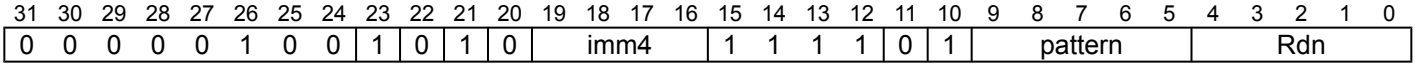
UQINCW (scalar)

Unsigned saturating increment scalar by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment the scalar destination. The result is saturated to the general-purpose register's unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.

It has encodings from 2 classes: 32-bit and 64-bit

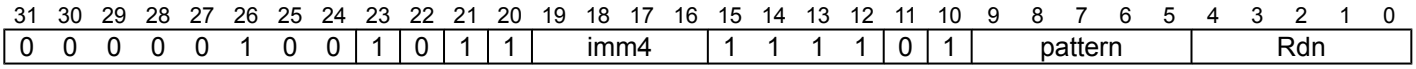
32-bit



32-bit

```
UQINCW <Wdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 32;
```

64-bit



64-bit

```
UQINCW <Xdn>{, <pattern>{, MUL #<imm>}}

if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Rdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
integer ssize = 64;
```

Assembler Symbols

<Wdn>	Is the 32-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<Xdn>	Is the 64-bit name of the source and destination general-purpose register, encoded in the "Rdn" field.
<pattern>	Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer count = DecodePredCount(pat, esize);
bits(ssize) operand1 = X[dn];
bits(ssize) result;

integer element1 = Int(operand1, unsigned);
(result, -) = SatQ(element1 + (count * imm), ssize, unsigned);
X[dn] = Extend(result, 64, unsigned);
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

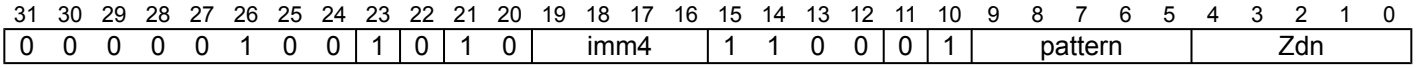
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQINCW (vector)

Unsigned saturating increment vector by multiple of 32-bit predicate constraint element count.

Determines the number of active 32-bit elements implied by the named predicate constraint, multiplies that by an immediate in the range 1 to 16 inclusive, and then uses the result to increment all destination vector elements. The results are saturated to the 32-bit unsigned integer range.
The named predicate constraint limits the number of active elements in a single predicate to:
* A fixed number (VL1 to VL256)
* The largest power of two (POW2)
* The largest multiple of three or four (MUL3 or MUL4)
* All available, implicitly a multiple of two (ALL).
Unspecified or out of range constraint encodings generate an empty predicate or zero element count rather than Undefined Instruction exception.



SVE

```
UQINCW <Zdn>.S{, <pattern>{, MUL #<imm>}}
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 32;
integer dn = UInt(Zdn);
bits(5) pat = pattern;
integer imm = UInt(imm4) + 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<pattern> Is the optional pattern specifier, defaulting to ALL, encoded in “pattern”:

pattern	<pattern>
00000	POW2
00001	VL1
00010	VL2
00011	VL3
00100	VL4
00101	VL5
00110	VL6
00111	VL7
01000	VL8
01001	VL16
01010	VL32
01011	VL64
01100	VL128
01101	VL256
0111x	#uimm5
101x1	#uimm5
10110	#uimm5
1x0x1	#uimm5
1x010	#uimm5
1xx00	#uimm5
11101	MUL4
11110	MUL3
11111	ALL

<imm> Is the immediate multiplier, in the range 1 to 16, defaulting to 1, encoded in the "imm4" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer count = DecodePredCount(pat, esize);
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 + (count * imm), esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

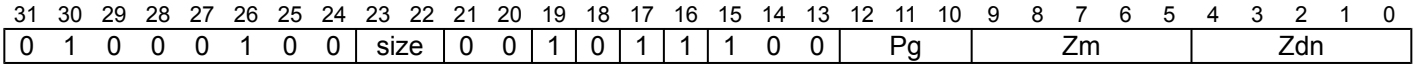
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQRSHL

Unsigned saturating rounding shift left by vector (predicated).

Shift active unsigned elements of the first source vector by corresponding elements of the second source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQRSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = UnsignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

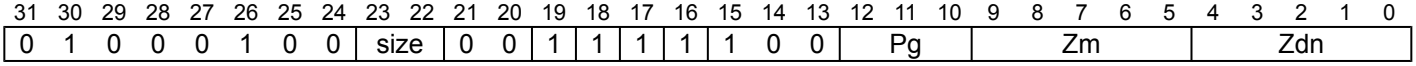
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQRSHLR

Unsigned saturating rounding shift left reversed vectors (predicated).

Shift active unsigned elements of the second source vector by corresponding elements of the first source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQRSHLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[m];
bits(VL) operand2 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = UnsignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand2, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

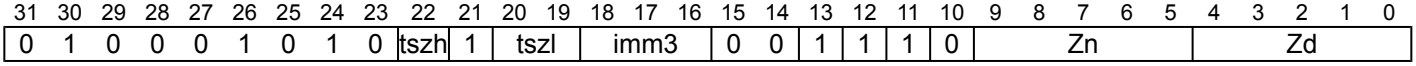
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQRSHRNB

Unsigned saturating rounding shift right narrow by immediate (bottom).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the rounded results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
UQRSHRNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (UInt(element) + round_const) >> shift;
    Elem[result, 2*e + 0, esize] = UnsignedSat(res, esize);
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

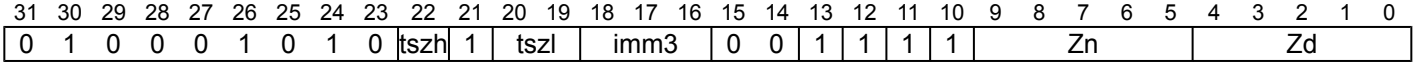
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQRSHRNT

Unsigned saturating rounding shift right narrow by immediate (top).

Shift each unsigned integer value in the source vector elements by an immediate value, and place the rounded results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
UQRSHRNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = (UInt(element) + round_const) >> shift;
    Elem[result, 2*e + 1, esize] = UnsignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

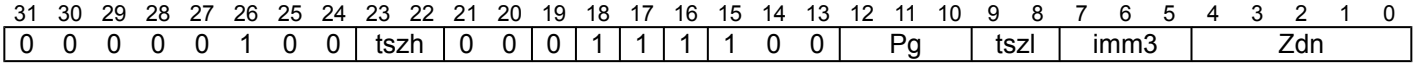
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQSHL (immediate)

Unsigned saturating shift left by immediate.

Shift left by immediate each active unsigned element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 << shift;
        Elem[result, e, esize] = UnsignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

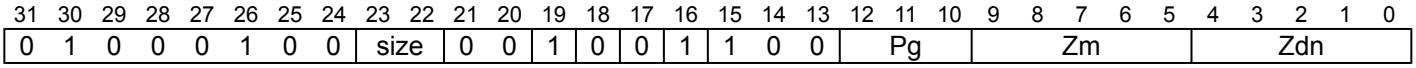
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UQSHL (vectors)

Unsigned saturating shift left by vector (predicated).

Shift active unsigned elements of the first source vector by corresponding elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    if ElemP[mask, e, esize] == '1' then
        integer res = element << shift;
        Elem[result, e, esize] = UnsignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

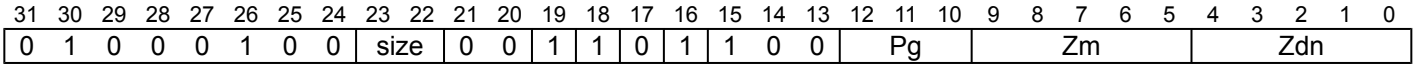
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQSHLR

Unsigned saturating shift left reversed vectors (predicated).

Shift active unsigned elements of the second source vector by corresponding elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQSHLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[m];
bits(VL) operand2 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    if ElemP[mask, e, esize] == '1' then
        integer res = element << shift;
        Elem[result, e, esize] = UnsignedSat(res, esize);
    else
        Elem[result, e, esize] = Elem[operand2, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

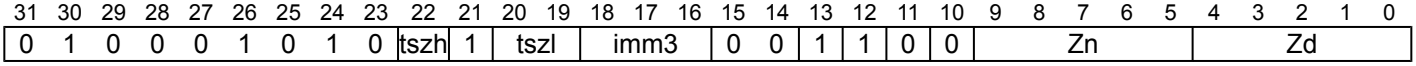
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQSHRNB

Unsigned saturating shift right narrow by immediate (bottom).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the truncated results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
UQSHRNB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = UInt(element) >> shift;
    Elem[result, 2*e + 0, esize] = UnsignedSat(res, esize);
    Elem[result, 2*e + 1, esize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

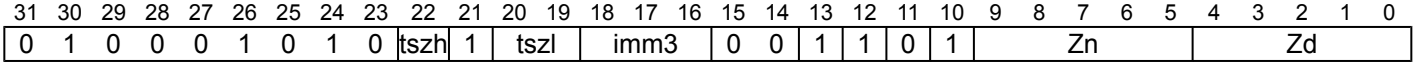
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UQSHRNT

Unsigned saturating shift right narrow by immediate (top).

Shift each unsigned integer value in the source vector elements right by an immediate value, and place the truncated results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged. Each result element is saturated to the half-width N-bit element's unsigned integer range 0 to (2^N)-1. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
UQSHRNT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(2*esize) element = Elem[operand, e, 2*esize];
    integer res = UInt(element) >> shift;
    Elem[result, 2*e + 1, esize] = UnsignedSat(res, esize);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

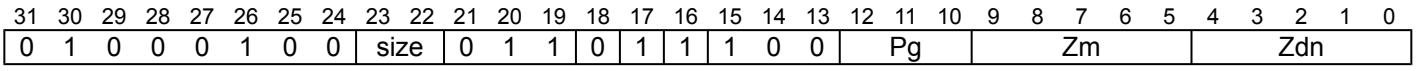
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UQSUB (vectors, predicated)

Unsigned saturating subtraction (predicated).

Subtract active unsigned elements of the second source vector from corresponding unsigned elements of the first source vector and destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQSUB <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = UInt(Sat(element1 - element2, esize, unsigned));
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

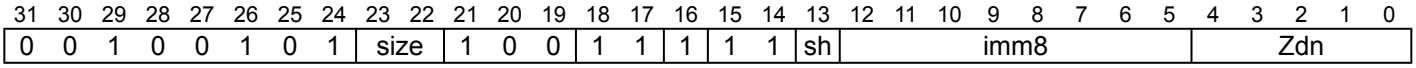
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

UQSUB (immediate)

Unsigned saturating subtract immediate (unpredicated).

Unsigned saturating subtract an unsigned immediate from each element of the source vector, and destructively place the results in the corresponding elements of the source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. This instruction is unpredicated.
The immediate is an unsigned value in the range 0 to 255, and for element widths of 16 bits or higher it may also be a positive multiple of 256 in the range 256 to 65280.
The immediate is encoded in 8 bits with an optional left shift by 8. The preferred disassembly when the shift option is specified is "#<uimm8>, LSL #8". However an assembler and disassembler may also allow use of the shifted 16-bit value unless the immediate is 0 and the shift amount is 8, which must be unambiguously described as "#0, LSL #8".



SVE

```
UQSUB <Zdn>.<T>, <Zdn>.<T>, #<imm>{, <shift>}
```

```
if !HaveSVE() then UNDEFINED;
if size:sh == '001' then UNDEFINED;
integer esize = 8 << UInt(size);
integer dn = UInt(Zdn);
integer imm = UInt(imm8);
if sh == '1' then imm = imm << 8;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<imm> Is an unsigned immediate in the range 0 to 255, encoded in the "imm8" field.

<shift> Is the optional left shift to apply to the immediate, defaulting to LSL #0 and encoded in “sh”:

sh	<shift>
0	LSL #0
1	LSL #8

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - imm, esize, unsigned);

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

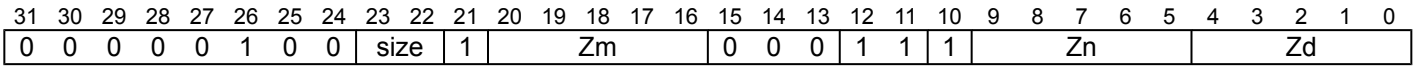
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQSUB (vectors, unpredicated)

Unsigned saturating subtract vectors (unpredicated).

Unsigned saturating subtract all elements of the second source vector from corresponding elements of the first source vector and place the results in the corresponding elements of the destination vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. This instruction is unpredicated.



SVE

```
UQSUB <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, e, esize], unsigned);
    integer element2 = Int(Elem[operand2, e, esize], unsigned);
    (Elem[result, e, esize], -) = SatQ(element1 - element2, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

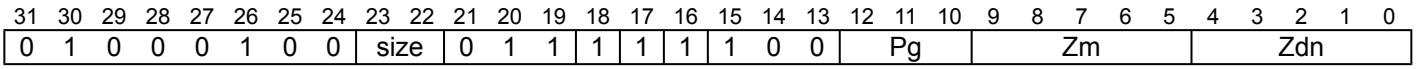
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

(old) htmldiff from- (new)

UQSUBR

Unsigned saturating subtraction reversed vectors (predicated).

Subtract active unsigned elements of the first source vector from corresponding unsigned elements of the second source vector and destructively place the results in the corresponding elements of the first source vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
UQSUBR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = UInt(Sat(element2 - element1, esize, unsigned));
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

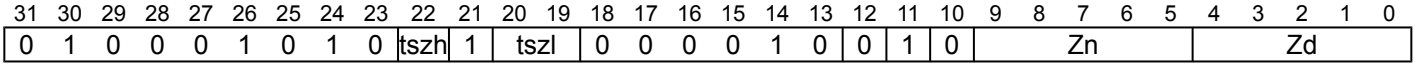
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQXTNB

Unsigned saturating extract narrow (bottom).

Saturate the unsigned integer value in each source element to half the original source element width, and place the results in the even-numbered half-width destination elements, while setting the odd-numbered elements to zero.



SVE2

```
UQXTNB <Zd>.<T>, <Zn>.<Tb>

if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '001' esize = 16;
    when '010' esize = 32;
    when '100' esize = 64;
    otherwise UNDEFINED;
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	10	H
x	11	RESERVED
1	00	S
1	01	RESERVED
1	10	RESERVED

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	10	S
x	11	RESERVED
1	00	D
1	01	RESERVED
1	10	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result;
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    bits(halfesize) res = UnsignedSat(element1, halfesize);
    Elem[result, 2*e + 0, halfesize] = res;
    Elem[result, 2*e + 1, halfesize] = Zeros();

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

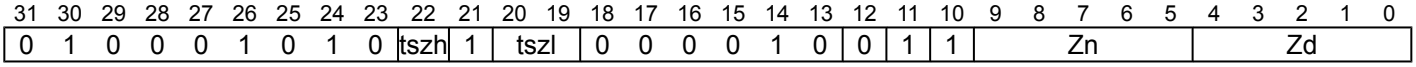
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

UQXTNT

Unsigned saturating extract narrow (top).

Saturate the unsigned integer value in each source element to half the original source element width, and place the results in the odd-numbered half-width destination elements, leaving the even-numbered elements unchanged.



SVE2

```
UQXTNT <Zd>.<T>, <Zn>.<Tb>

if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '001' esize = 16;
    when '010' esize = 32;
    when '100' esize = 64;
    otherwise UNDEFINED;
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	B
0	10	H
x	11	RESERVED
1	00	S
1	01	RESERVED
1	10	RESERVED

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	H
0	10	S
x	11	RESERVED
1	00	D
1	01	RESERVED
1	10	RESERVED

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) result = Z[d];
integer halfesize = esize DIV 2;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    bits(halfesize) res = UnsignedSat(element1, halfesize);
    Elem[result, 2*e + 1, halfesize] = res;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

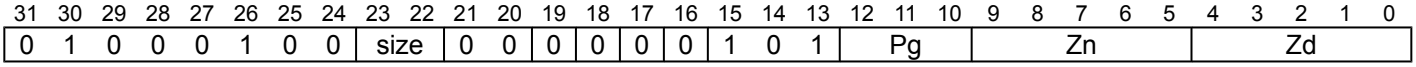
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

URECPE

Unsigned reciprocal estimate (predicated).

Find the approximate reciprocal of each active unsigned element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
URECPE <Zd>.S, <Pg>/M, <Zn>.S
```

```
if !HaveSVE2() then UNDEFINED;
if size != '10' then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = UnsignedRecipEstimate(element);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

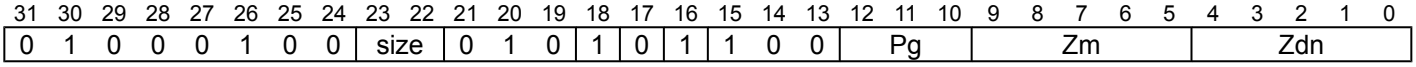
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

URHADD

Unsigned rounding halving addition.

Add active unsigned elements of the first source vector to corresponding unsigned elements of the second source vector, shift right one bit, and destructively place the rounded results in the corresponding elements of the first source vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
URHADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;
integer round_const = 1;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = element1 + element2 + round_const;
        Elem[result, e, esize] = res<esize:1>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

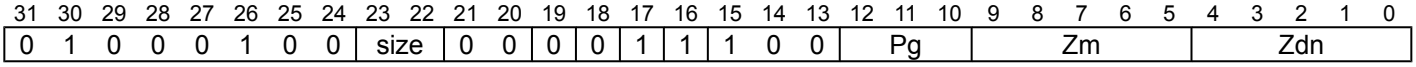
(old) htmldiff from- (new)

(old) htmldiff from- (new)

URSHL

Unsigned rounding shift left by vector (predicated).

Shift active unsigned elements of the first source vector by corresponding elements of the second source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Inactive elements in the destination vector register remain unmodified.



SVE2

```
URSHL <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

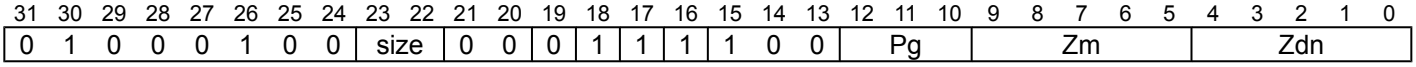
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

URSHLR

Unsigned rounding shift left reversed vectors (predicated).

Shift active unsigned elements of the second source vector by corresponding elements of the first source vector and destructively place the rounded results in the corresponding elements of the first source vector. A positive shift amount performs a left shift, otherwise a right shift by the negated shift amount is performed. Inactive elements in the destination vector register remain unmodified.



SVE2

```
URSHLR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer m = UInt(Zm);
integer dn = UInt(Zdn);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[m];
bits(VL) operand2 = Z[dn];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]);
    integer shift = ShiftSat(SInt(Elem[operand2, e, esize]), esize);
    integer round_const = 1 << (-shift - 1); // 0 for left shift, 2^(n-1) for right shift
    if ElemP[mask, e, esize] == '1' then
        integer res = (element + round_const) << shift;
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand2, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

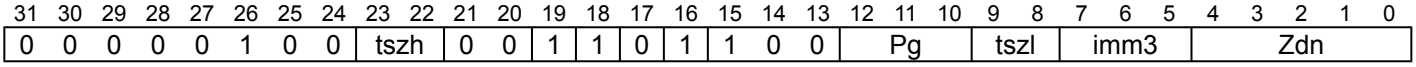
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

URSHR

Unsigned rounding shift right by immediate.

Shift right by immediate each active unsigned element of the source vector, and destructively place the rounded results in the corresponding elements of the source vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. Inactive elements in the destination vector register remain unmodified.



SVE2

```
URSHR <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zdn> Is the name of the source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(PL) mask = P[g];
bits(VL) result;
integer round_const = 1 << (shift-1);

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    if ElemP[mask, e, esize] == '1' then
        integer res = (element1 + round_const) >> shift;
        Elem[result, e, esize] = res<esize-1:0>;
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

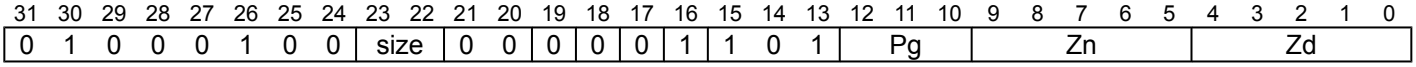
- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

URSQRTE

Unsigned reciprocal square root estimate (predicated).

Find the approximate reciprocal square root of each active unsigned element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.



SVE2

```
URSQRTE <Zd>.S, <Pg>/M, <Zn>.S
```

```
if !HaveSVE2() then UNDEFINED;
if size != '10' then UNDEFINED;
integer esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd>	Is the name of the destination scalable vector register, encoded in the "Zd" field.
<Pg>	Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.
<Zn>	Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = UnsignedRSqrtEstimate(element);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

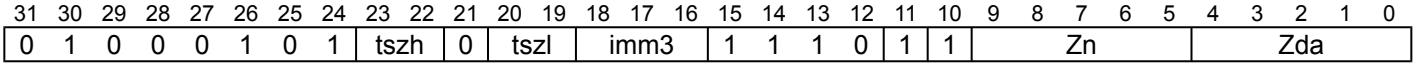
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

URSRA

Unsigned rounding shift right and accumulate (immediate).

Shift right by immediate each unsigned element of the source vector, inserting zeroes, and add the rounded intermediate result destructively to the corresponding elements of the addend vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
URSRA <Zda>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer da = UInt(Zda);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[da];
bits(VL) result;
integer round_const = 1 << (shift - 1);

for e = 0 to elements-1
    integer element = (UInt(Elem[operand1, e, esize]) + round_const) >> shift;
    Elem[result, e, esize] = Elem[operand2, e, esize] + element<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

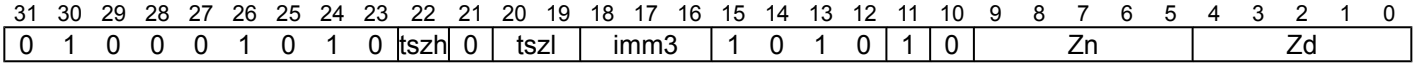
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USHLLB

Unsigned shift left long by immediate (bottom).

Shift left by immediate each even-numbered unsigned element of the source vector, and place the results in the overlapping double-width elements of the destination vector. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. This instruction is unpredicated.



SVE2

```
USHLLB <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element = Elem[operand, 2*e + 0, esize];
    integer shifted_value = UInt(element) << shift;
    Elem[result, e, 2*esize] = shifted_value<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

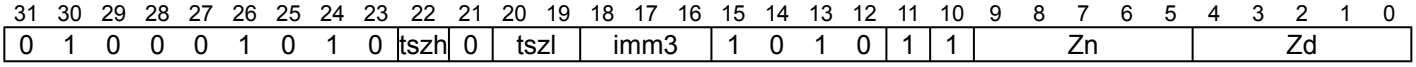
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USHLLT

Unsigned shift left long by immediate (top).

Shift left by immediate each odd-numbered unsigned element of the source vector, and place the results in the overlapping double-width elements of the destination vector. The immediate shift amount is an unsigned value in the range 0 to number of bits per element minus 1. This instruction is unpredicated.



SVE2

```
USHLLT <Zd>.<T>, <Zn>.<Tb>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(3) tsize = tszh:tszl;
case tsize of
    when '000' UNDEFINED;
    when '001' esize = 8;
    when '01x' esize = 16;
    when '1xx' esize = 32;
integer n = UInt(Zn);
integer d = UInt(Zd);
integer shift = UInt(tsize:imm3) - esize;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
0	00	RESERVED
0	01	H
0	1x	S
1	xx	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<Tb>
0	00	RESERVED
0	01	B
0	1x	H
1	xx	S

<const> Is the immediate shift amount, in the range 0 to number of bits per element minus 1, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV (2 * esize);
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element = Elem[operand, 2*e + 1, esize];
    integer shifted_value = UInt(element) << shift;
    Elem[result, e, 2*esize] = shifted_value<2*esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

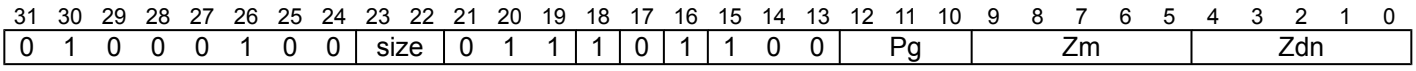
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USQADD

Unsigned saturating addition of signed value.

Add active signed elements of the source vector to the corresponding unsigned elements of the addend vector, and destructively place the results in the corresponding elements of the addend vector. Each result element is saturated to the N-bit element's unsigned integer range 0 to (2^N)-1. Inactive elements in the destination vector register remain unmodified.



SVE2

```
USQADD <Zdn>.<T>, <Pg>/M, <Zdn>.<T>, <Zm>.<T>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer g = UInt(Pg);
integer dn = UInt(Zdn);
integer m = UInt(Zm);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = UnsignedSat(UInt(element1) + SInt(element2), esize);
    else
        Elem[result, e, esize] = Elem[operand1, e, esize];

Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

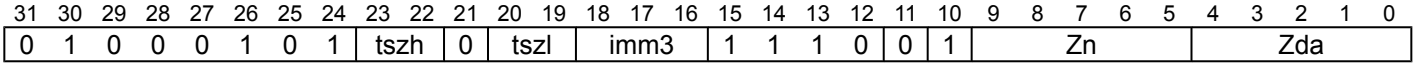
(old) htmldiff from- (new)

(old) htmldiff from- (new)

USRA

Unsigned shift right and accumulate (immediate).

Shift right by immediate each unsigned element of the source vector, inserting zeroes, and add the truncated intermediate result destructively to the corresponding elements of the addend vector. The immediate shift amount is an unsigned value in the range 1 to number of bits per element. This instruction is unpredicated.



SVE2

```
USRA <Zda>.<T>, <Zn>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer n = UInt(Zn);
integer da = UInt(Zda);
integer shift = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zda> Is the name of the third source and destination scalable vector register, encoded in the "Zda" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[da];
bits(VL) result;

for e = 0 to elements-1
    integer element = UInt(Elem[operand1, e, esize]) >> shift;
    Elem[result, e, esize] = Elem[operand2, e, esize] + element<esize-1:0>;

Z[da] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.

    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

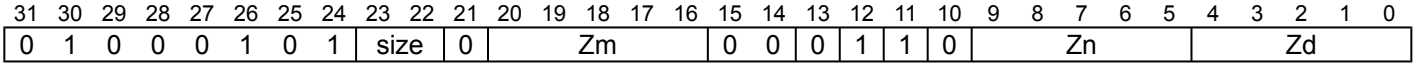
- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USUBLB

Unsigned subtract long (bottom).

Subtract the even-numbered unsigned elements of the second source vector from the corresponding unsigned elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
USUBLB <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 0;
integer sel2 = 0;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 - element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

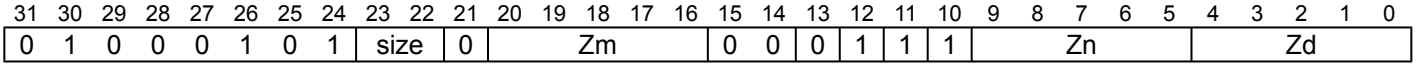
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USUBLT

Unsigned subtract long (top).

Subtract the odd-numbered unsigned elements of the second source vector from the corresponding unsigned elements of the first source vector, and place the results in the overlapping double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
USUBLT <Zd>.<T>, <Zn>.<Tb>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer sel1 = 1;
integer sel2 = 1;
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = Int(Elem[operand1, 2*e + sel1, esize DIV 2], unsigned);
    integer element2 = Int(Elem[operand2, 2*e + sel2, esize DIV 2], unsigned);
    integer res = element1 - element2;
    Elem[result, e, esize] = res<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

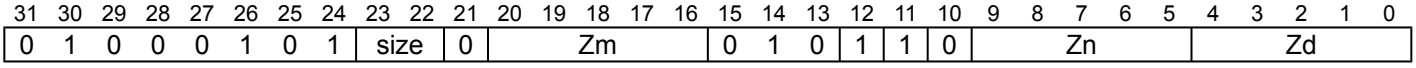
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USUBWB

Unsigned subtract wide (bottom).

Subtract the even-numbered unsigned elements of the second source vector from the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated.



SVE2

```
USUBWB <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, 2*e + 0, esize DIV 2]);
    Elem[result, e, esize] = (element1 - element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

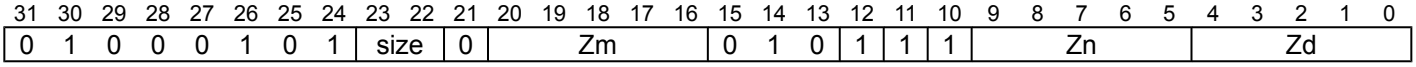
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

USUBWT

Unsigned subtract wide (top).

Subtract the odd-numbered unsigned elements of the second source vector from the overlapping double-width elements of the first source vector and place the results in the corresponding double-width elements of the destination vector. This instruction is unpredicated. This instruction is unpredicated.



SVE2

```
USUBWT <Zd>.<T>, <Zn>.<T>, <Zm>.<Tb>
```

```
if !HaveSVE2() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    integer element1 = UInt(Elem[operand1, e, esize]);
    integer element2 = UInt(Elem[operand2, 2*e + 1, esize DIV 2]);
    Elem[result, e, esize] = (element1 - element2)<esize-1:0>;

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

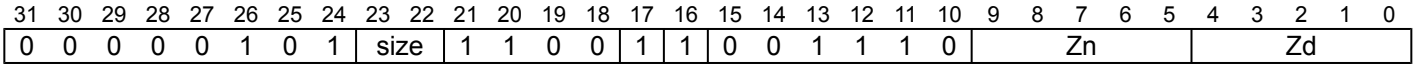
UUNPKHI, UUNPKLO

Unsigned unpack and extend half of vector.

Unpack elements from the lowest or highest half of the source vector and then zero-extend them to place in elements of twice their size within the destination vector. This instruction is unpredicated.

It has encodings from 2 classes: High half and Low half

High half

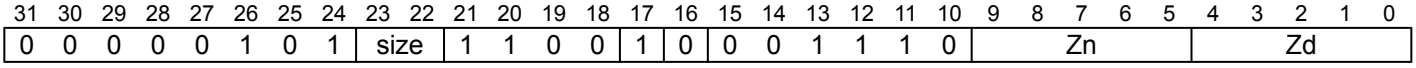


High half

```
UUNPKHI <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = TRUE;
boolean hi = TRUE;
```

Low half



Low half

```
UUNPKLO <Zd>.<T>, <Zn>.<Tb>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = TRUE;
boolean hi = FALSE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

<Tb> Is the size specifier, encoded in “size”:

size	<Tb>
00	RESERVED
01	B
10	H
11	S

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
integer hsize = esize DIV 2;
bits(VL) operand = Z[n];
bits(VL) result;

for e = 0 to elements-1
    bits(hsize) element = if hi then Elem[operand, e + elements, hsize] else Elem[operand, e, hsize];
    Elem[result, e, esize] = Extend(element, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

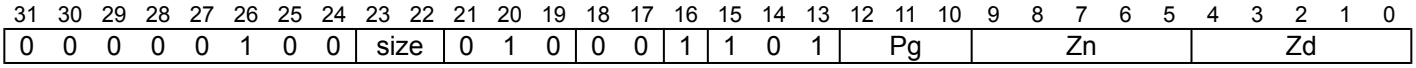
UXTB, UXTH, UXTW

Unsigned byte / halfword / word extend (predicated).

Zero-extend the least-significant sub-element of each active element of the source vector, and place the results in the corresponding elements of the destination vector. Inactive elements in the destination vector register remain unmodified.

It has encodings from 3 classes: Byte , Halfword and Word

Byte

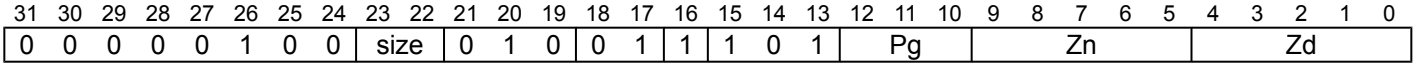


Byte

```
UXTB <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size == '00' then UNDEFINED;
integer esize = 8 << UInt(size);
integer s_esize = 8;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = TRUE;
```

Halfword

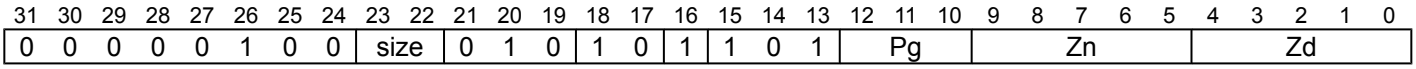


Halfword

```
UXTH <Zd>.<T>, <Pg>/M, <Zn>.<T>
```

```
if !HaveSVE() then UNDEFINED;
if size != '1x' then UNDEFINED;
integer esize = 8 << UInt(size);
integer s_esize = 16;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = TRUE;
```

Word



Word

```
UXTW <Zd>.D, <Pg>/M, <Zn>.D
```

```
if !HaveSVE() then UNDEFINED;
if size != '11' then UNDEFINED;
integer esize = 8 << UInt(size);
integer s_esize = 32;
integer g = UInt(Pg);
integer n = UInt(Zn);
integer d = UInt(Zd);
boolean unsigned = TRUE;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> For the byte variant: is the size specifier, encoded in “size”:

size	<T>
00	RESERVED
01	H
10	S
11	D

For the halfword variant: is the size specifier, encoded in “size<0>”:

size<0>	<T>
0	S
1	D

<Pg> Is the name of the governing scalable predicate register P0-P7, encoded in the "Pg" field.

<Zn> Is the name of the source scalable vector register, encoded in the "Zn" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = P[g];
bits(VL) operand  = Z[n];
bits(VL) result = Z[d];

for e = 0 to elements-1
    bits(esize) element = Elem[operand, e, esize];
    if ElemP[mask, e, esize] == '1' then
        Elem[result, e, esize] = Extend(element<s_esize-1:0>, esize, unsigned);

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its operand registers when its governing predicate register contains the same value for each execution.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.
- A predicated MOVPRFX instruction using the same governing predicate register and source element size as this instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

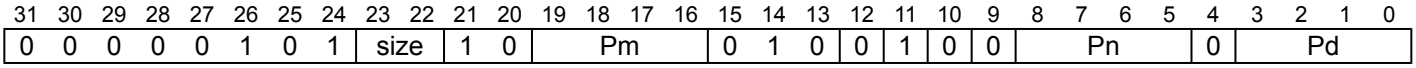
UZP1, UZP2 (predicates)

Concatenate even or odd elements from two predicates.

Concatenate adjacent even or odd-numbered elements from the first and second source predicates and place in elements of the destination predicate. This instruction is unpredicated.

It has encodings from 2 classes: Even and Odd

Even

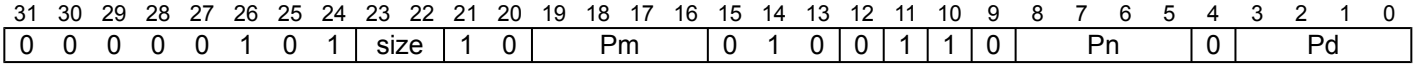


Even

```
UZP1 <Pd>.<T>, <Pn>.<T>, <Pm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
integer part = 0;
```

Odd



Odd

```
UZP2 <Pd>.<T>, <Pn>.<T>, <Pm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
integer part = 1;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pn> Is the name of the first source scalable predicate register, encoded in the "Pn" field.

<Pm> Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

bits(PL*2) zipped = operand2:operand1;
for e = 0 to elements-1
    Elem[result, e, esize DIV 8] = Elem[zipped, 2*e+part, esize DIV 8];

P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

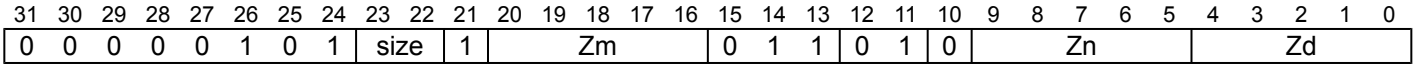
UZP1, UZP2 (vectors)

Concatenate even or odd elements from two vectors.

Concatenate adjacent even or odd-numbered elements from the first and second source vectors and place in elements of the destination vector. This instruction is unpredicated.

It has encodings from 2 classes: Even and Odd

Even

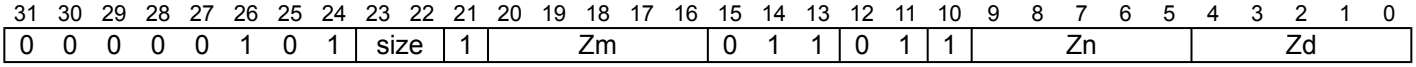


Even

```
UZP1 <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer part = 0;
```

Odd



Odd

```
UZP2 <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer part = 1;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

bits(VL*2) zipped = operand2:operand1;
for e = 0 to elements-1
    Elem[result, e, esize] = Elem[zipped, 2*e+part, esize];

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILEGE

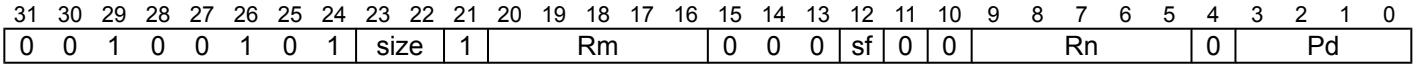
While decrementing signed scalar greater than or equal to scalar.

Generate a predicate that starting from the highest numbered element is true while the decrementing value of the first, signed scalar operand is greater than or equal to the second scalar operand and false thereafter down to the lowest numbered element.

If the second scalar operand is equal to the minimum signed integer value then a condition which includes an equality test can never fail and the result will be an all-true predicate.

The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is decremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.

The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
WHILEGE <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = FALSE;
SVECmp op = Cmp_GE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = elements-1 downto 0
    boolean cond;
    case op of
        when Cmp_GT cond = (Int(operand1, unsigned) >  Int(operand2, unsigned));
        when Cmp_GE cond = (Int(operand1, unsigned) >= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 - 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

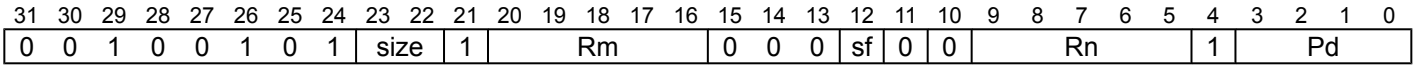
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILEGT

While decrementing signed scalar greater than scalar.

Generate a predicate that starting from the highest numbered element is true while the decrementing value of the first, signed scalar operand is greater than the second scalar operand and false thereafter down to the lowest numbered element.
The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is decremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.
The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
WHILEGT <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = FALSE;
SVECmp op = Cmp_GT;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = elements-1 downto 0
    boolean cond;
    case op of
        when Cmp_GT cond = (Int(operand1, unsigned) >  Int(operand2, unsigned));
        when Cmp_GE cond = (Int(operand1, unsigned) >= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 - 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

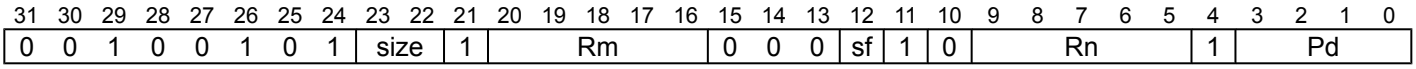
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

WHILEHI

While decrementing unsigned scalar higher than scalar.

Generate a predicate that starting from the highest numbered element is true while the decrementing value of the first, unsigned scalar operand is higher than the second scalar operand and false thereafter down to the lowest numbered element.
The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is decremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.
The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
WHILEHI <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = TRUE;
SVECmp op = Cmp_GT;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = elements-1 downto 0
    boolean cond;
    case op of
        when Cmp_GT cond = (Int(operand1, unsigned) >  Int(operand2, unsigned));
        when Cmp_GE cond = (Int(operand1, unsigned) >= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 - 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILEHS

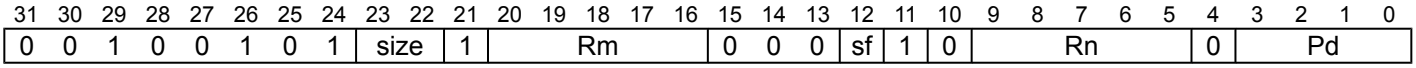
While decrementing unsigned scalar higher or same as scalar.

Generate a predicate that starting from the highest numbered element is true while the decrementing value of the first, unsigned scalar operand is higher or same as the second scalar operand and false thereafter down to the lowest numbered element.

If the second scalar operand is equal to the minimum unsigned integer value then a condition which includes an equality test can never fail and the result will be an all-true predicate.

The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is decremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.

The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
WHILEHS <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = TRUE;
SVECmp op = Cmp_GE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = elements-1 downto 0
    boolean cond;
    case op of
        when Cmp_GT cond = (Int(operand1, unsigned) >  Int(operand2, unsigned));
        when Cmp_GE cond = (Int(operand1, unsigned) >= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 - 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

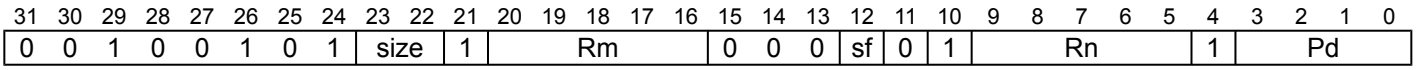
Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

WHILELE

While incrementing signed scalar less than or equal to scalar.

Generate a predicate that starting from the lowest numbered element is true while the incrementing value of the first, signed scalar operand is less than or equal to the second scalar operand and false thereafter up to the highest numbered element.
If the second scalar operand is equal to the maximum signed integer value then a condition which includes an equality test can never fail and the result will be an all-true predicate.
The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is incremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.
The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE

```
WHILELE <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = FALSE;
SVECmp op = Cmp_LE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = 0 to elements-1
    boolean cond;
    case op of
        when Cmp_LT cond = (Int(operand1, unsigned) <  Int(operand2, unsigned));
        when Cmp_LE cond = (Int(operand1, unsigned) <= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 + 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

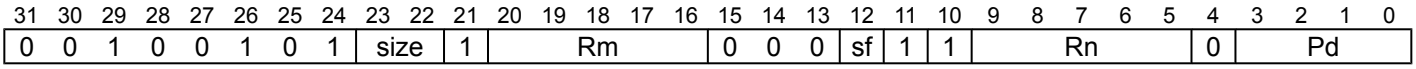
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILELO

While incrementing unsigned scalar lower than scalar.

Generate a predicate that starting from the lowest numbered element is true while the incrementing value of the first, unsigned scalar operand is lower than the second scalar operand and false thereafter up to the highest numbered element.
The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is incremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.
The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE

```
WHILELO <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = TRUE;
SVECmp op = Cmp_LT;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = 0 to elements-1
    boolean cond;
    case op of
        when Cmp_LT cond = (Int(operand1, unsigned) <  Int(operand2, unsigned));
        when Cmp_LE cond = (Int(operand1, unsigned) <= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 + 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

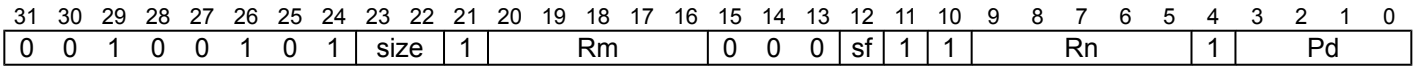
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILELS

While incrementing unsigned scalar lower or same as scalar.

Generate a predicate that starting from the lowest numbered element is true while the incrementing value of the first, unsigned scalar operand is lower or same as the second scalar operand and false thereafter up to the highest numbered element.
If the second scalar operand is equal to the maximum unsigned integer value then a condition which includes an equality test can never fail and the result will be an all-true predicate.
The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is incremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.
The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE

```
WHILELS <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = TRUE;
SVECmp op = Cmp_LE;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = 0 to elements-1
    boolean cond;
    case op of
        when Cmp_LT cond = (Int(operand1, unsigned) <  Int(operand2, unsigned));
        when Cmp_LE cond = (Int(operand1, unsigned) <= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 + 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

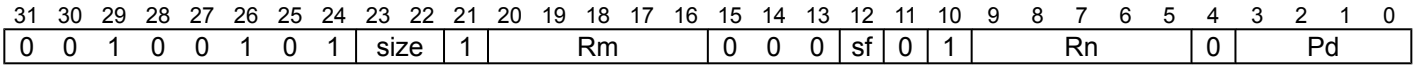
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILELT

While incrementing signed scalar less than scalar.

Generate a predicate that starting from the lowest numbered element is true while the incrementing value of the first, signed scalar operand is less than the second scalar operand and false thereafter up to the highest numbered element.
The full width of the scalar operands is significant for the purposes of comparison, and the full width first operand is incremented by one for each destination predicate element, irrespective of the predicate result element size. The first general-purpose source register is not itself updated.
The predicate result is placed in the predicate destination register. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE

```
WHILELT <Pd>.<T>, <R><n>, <R><m>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer rsize = 32 << UInt(sf);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
boolean unsigned = FALSE;
SVECmp op = Cmp_LT;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<R> Is a width specifier, encoded in “sf”:

sf	<R>
0	W
1	X

<n> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rn" field.

<m> Is the number [0-30] of the source general-purpose register or the name ZR (31), encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(rsize) operand1 = X[n];
bits(rsize) operand2 = X[m];
bits(PL) result;
boolean last = TRUE;

for e = 0 to elements-1
    boolean cond;
    case op of
        when Cmp_LT cond = (Int(operand1, unsigned) <  Int(operand2, unsigned));
        when Cmp_LE cond = (Int(operand1, unsigned) <= Int(operand2, unsigned));

    last = last && cond;
    ElemP[result, e, esize] = if last then '1' else '0';
    operand1 = operand1 + 1;

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

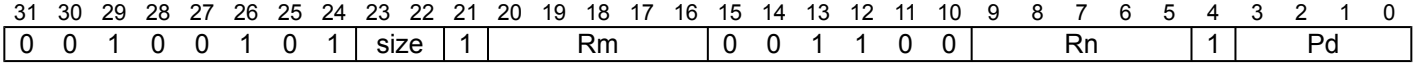
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILERW

While free of read-after-write conflicts.

This instruction checks two addresses for a conflict or overlap between address ranges of the form [addr,addr+VL÷8), where VL is the accessible vector length in bits, that could result in a loop-carried dependency through memory due to the use of these addresses by contiguous load and store instructions within the same iteration of a loop. Generate a predicate whose elements are true while the addresses cannot conflict within the same iteration, and false thereafter. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
WHILERW <Pd>.<T>, <Xn>, <Xm>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Xn> Is the 64-bit name of the first source general-purpose register, encoded in the "Rn" field.

<Xm> Is the 64-bit name of the second source general-purpose register, encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(64) src1 = X[n];
bits(64) src2 = X[m];
integer operand1 = UInt(src1);
integer operand2 = UInt(src2);
bits(PL) result;

integer diff = Abs(operand2 - operand1) DIV (esize DIV 8);
for e = 0 to elements-1
    if diff == 0 || e < diff then
        ElemP[result, e, esize] = '1';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

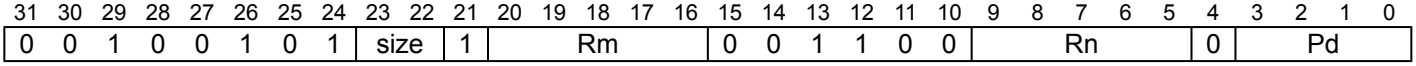
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

WHILEWR

While free of write-after-read/write conflicts.

This instruction checks two addresses for a conflict or overlap between address ranges of the form [addr,addr+VL÷8), where VL is the accessible vector length in bits, that could result in a loop-carried dependency through memory due to the use of these addresses by contiguous load and store instructions within the same iteration of a loop. Generate a predicate whose elements are true while the addresses cannot conflict within the same iteration, and false thereafter. Sets the FIRST (N), NONE (Z), !LAST (C) condition flags based on the predicate result, and the V flag to zero.



SVE2

```
WHILEWR <Pd>.<T>, <Xn>, <Xm>
```

```
if !HaveSVE2() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Rn);
integer m = UInt(Rm);
integer d = UInt(Pd);
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Xn> Is the 64-bit name of the first source general-purpose register, encoded in the "Rn" field.

<Xm> Is the 64-bit name of the second source general-purpose register, encoded in the "Rm" field.

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(PL) mask = Ones(PL);
bits(64) src1 = X[n];
bits(64) src2 = X[m];
integer operand1 = UInt(src1);
integer operand2 = UInt(src2);
bits(PL) result;

integer diff = (operand2 - operand1) DIV (esize DIV 8);
for e = 0 to elements-1
    if diff <= 0 || e < diff then
        ElemP[result, e, esize] = '1';
    else
        ElemP[result, e, esize] = '0';

PSTATE.<N,Z,C,V> = PredTest(mask, result, esize);
P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:

    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
    - The values of the data supplied in any of its registers.
    - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

WRFFR

Write the first-fault register.

Read the source predicate register and place in the first-fault register (FFR). This instruction is intended to restore a saved FFR and is not recommended for general use by applications.
This instruction requires that the source predicate contains a MONOTONIC predicate value, in which starting from bit 0 there are zero or more 1 bits, followed only by 0 bits in any remaining bit positions. If the source is not a monotonic predicate value, then the resulting value in the FFR will be UNPREDICTABLE. It is not possible to generate a non-monotonic value in FFR when using SETFFR followed by first-fault or non-fault loads.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	Pn				0	0	0	0	0

SVE

```
WRFFR <Pn>.B

if !HaveSVE() then UNDEFINED;
integer n = UInt(Pn);
```

Assembler Symbols

<Pn> Is the name of the source scalable predicate register, encoded in the "Pn" field.

Operation

```
CheckSVEEnabled();
bits(PL) operand = P[n];

hsb = HighestSetBit(operand);
if hsb < 0 || IsOnes(operand<hsb:0>) then
    FFR[] = operand;
else // not a monotonic predicate
    FFR[] = bits(PL) UNKNOWN;
```

Operational information

If PSTATE.DIT is 1:

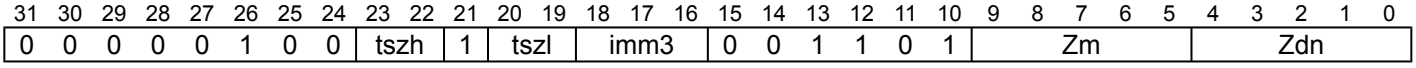
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

XAR

Bitwise exclusive OR and rotate right by immediate.

Bitwise exclusive OR the corresponding elements of the first and second source vectors, then rotate each result element right by an immediate amount. The final results are destructively placed in the corresponding elements of the destination and first source vector. This instruction is unpredicated.



SVE2

```
XAR <Zdn>.<T>, <Zdn>.<T>, <Zm>.<T>, #<const>
```

```
if !HaveSVE2() then UNDEFINED;
bits(4) tsize = tszh:tszl;
case tsize of
    when '0000' UNDEFINED;
    when '0001' esize = 8;
    when '001x' esize = 16;
    when '01xx' esize = 32;
    when '1xxx' esize = 64;
integer m = UInt(Zm);
integer dn = UInt(Zdn);
integer rot = (2 * esize) - UInt(tsize:imm3);
```

Assembler Symbols

<Zdn> Is the name of the first source and destination scalable vector register, encoded in the "Zdn" field.

<T> Is the size specifier, encoded in “tszh:tszl”:

tszh	tszl	<T>
00	00	RESERVED
00	01	B
00	1x	H
01	xx	S
1x	xx	D

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

<const> Is the immediate shift amount, in the range 1 to number of bits per element, encoded in "tsz:imm3".

Operation

```
CheckSVEEnabled();
integer elements = VL DIV esize;
bits(VL) operand1 = Z[dn];
bits(VL) operand2 = Z[m];
bits(VL) result;

for e = 0 to elements-1
    bits(esize) element1 = Elem[operand1, e, esize];
    bits(esize) element2 = Elem[operand2, e, esize];
    Elem[result, e, esize] = ROR(element1 EOR element2, rot);
Z[dn] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

This instruction might be immediately preceded in program order by a MOVPRFX instruction that conforms to all of the following requirements, otherwise the behavior of either or both instructions is UNPREDICTABLE:

- The MOVPRFX instruction must specify the same destination register as this instruction.
- The destination register must not refer to architectural register state referenced by any other source operand register of this instruction.

The MOVPRFX instructions that can be used with this instruction are as follows:

- An unpredicated MOVPRFX instruction.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

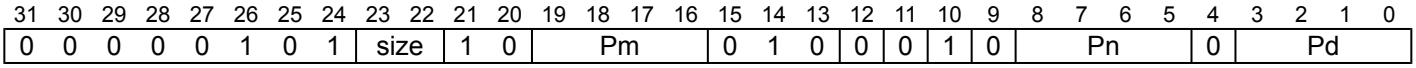
ZIP1, ZIP2 (predicates)

Interleave elements from two half predicates.

Interleave alternating elements from the lowest or highest halves of the first and second source predicates and place in elements of the destination predicate. This instruction is unpredicated.

It has encodings from 2 classes: High halves and Low halves

High halves

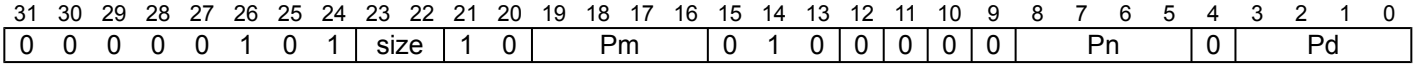


High halves

```
ZIP2 <Pd>.<T>, <Pn>.<T>, <Pm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
integer part = 1;
```

Low halves



Low halves

```
ZIP1 <Pd>.<T>, <Pn>.<T>, <Pm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Pn);
integer m = UInt(Pm);
integer d = UInt(Pd);
integer part = 0;
```

Assembler Symbols

<Pd> Is the name of the destination scalable predicate register, encoded in the "Pd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Pn> Is the name of the first source scalable predicate register, encoded in the "Pn" field.

<Pm> Is the name of the second source scalable predicate register, encoded in the "Pm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(PL) operand1 = P[n];
bits(PL) operand2 = P[m];
bits(PL) result;

integer base = part * pairs;
for p = 0 to pairs-1
    Elem[result, 2*p+0, esize DIV 8] = Elem[operand1, base+p, esize DIV 8];
    Elem[result, 2*p+1, esize DIV 8] = Elem[operand2, base+p, esize DIV 8];

P[d] = result;
```

Operational information

If PSTATE.DIT is 1:

- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

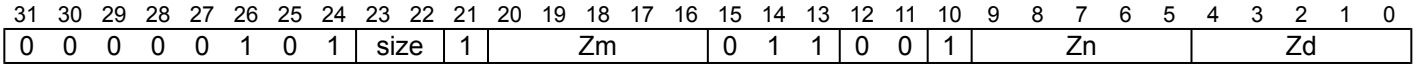
ZIP1, ZIP2 (vectors)

Interleave elements from two half vectors.

Interleave alternating elements from the lowest or highest halves of the first and second source vectors and place in elements of the destination vector. This instruction is unpredicated.

It has encodings from 2 classes: High halves and Low halves

High halves

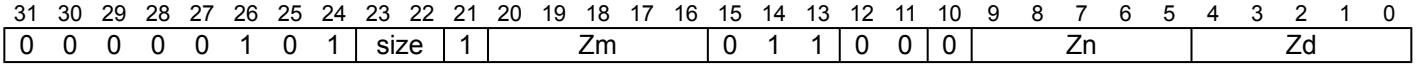


High halves

```
ZIP2 <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer part = 1;
```

Low halves



Low halves

```
ZIP1 <Zd>.<T>, <Zn>.<T>, <Zm>.<T>
```

```
if !HaveSVE() then UNDEFINED;
integer esize = 8 << UInt(size);
integer n = UInt(Zn);
integer m = UInt(Zm);
integer d = UInt(Zd);
integer part = 0;
```

Assembler Symbols

<Zd> Is the name of the destination scalable vector register, encoded in the "Zd" field.

<T> Is the size specifier, encoded in “size”:

size	<T>
00	B
01	H
10	S
11	D

<Zn> Is the name of the first source scalable vector register, encoded in the "Zn" field.

<Zm> Is the name of the second source scalable vector register, encoded in the "Zm" field.

Operation

```
CheckSVEEnabled();
integer pairs = VL DIV (esize * 2);
bits(VL) operand1 = Z[n];
bits(VL) operand2 = Z[m];
bits(VL) result;

integer base = part * pairs;
for p = 0 to pairs-1
    Elem[result, 2*p+0, esize] = Elem[operand1, base+p, esize];
    Elem[result, 2*p+1, esize] = Elem[operand2, base+p, esize];

Z[d] = result;
```

Operational information

If PSTATE.DIT is 1:

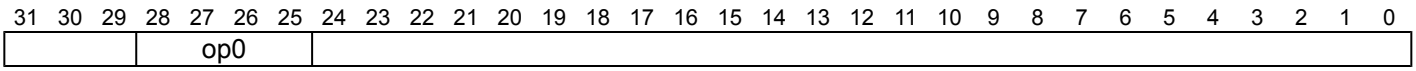
- The execution time of this instruction is independent of:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.
- The response of this instruction to asynchronous exceptions does not vary based on:
  - The values of the data supplied in any of its registers.
  - The values of the NZCV flags.

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

(old) htmldiff from- (new)

(old) htmldiff from- (new)

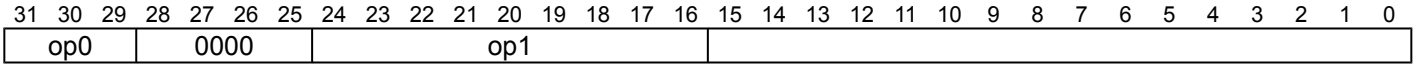
Top-level encodings for A64



Decode fields op0	Instruction details
0000	Reserved
0001	UNALLOCATED
0010	SVE encodings
0011	UNALLOCATED
100x	Data Processing -- Immediate
101x	Branches, Exception Generating and System instructions
x1x0	Loads and Stores
x101	Data Processing -- Register
x111	Data Processing -- Scalar Floating-Point and Advanced SIMD

Reserved

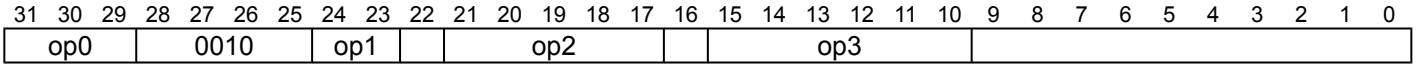
These instructions are under the top-level.



Decode fields op0	Decode fields op1	Instruction details
000	000000000	UDF
	!= 000000000	UNALLOCATED
!= 000		UNALLOCATED

SVE encodings

These instructions are under the top-level.



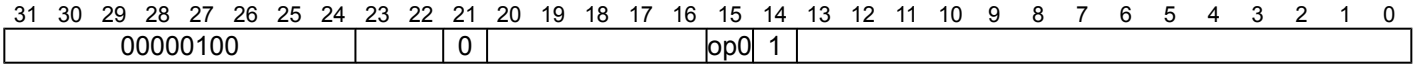
Decode fields op0	op1	op2	op3	Instruction details
000	0x	0xxxx	x1xxxx	SVE Integer Multiply-Add - Predicated
000	0x	0xxxx	000xxx	SVE Integer Binary Arithmetic - Predicated
000	0x	0xxxx	001xxx	SVE Integer Reduction
000	0x	0xxxx	100xxx	SVE Bitwise Shift - Predicated
000	0x	0xxxx	101xxx	SVE Integer Unary Arithmetic - Predicated
000	0x	1xxxx	000xxx	SVE integer add/subtract vectors (unpredicated)
000	0x	1xxxx	001xxx	SVE Bitwise Logical - Unpredicated
000	0x	1xxxx	0100xx	SVE Index Generation
000	0x	1xxxx	0101xx	SVE Stack Allocation
000	0x	1xxxx	011xxx	SVE2 Integer Multiply - Unpredicated
000	0x	1xxxx	100xxx	SVE Bitwise Shift - Unpredicated

000	0x	1xxxx	1010xx	SVE address generation
000	0x	1xxxx	1011xx	SVE Integer Misc - Unpredicated
000	0x	1xxxx	11xxxx	SVE Element Count
000	1x	00xxx		SVE Bitwise Immediate
000	1x	01xxx		SVE Integer Wide Immediate - Predicated
000	1x	1xxxx	001xxx	SVE Permute Vector - Unpredicated
000	1x	1xxxx	010xxx	SVE Permute Predicate
000	1x	1xxxx	011xxx	SVE permute vector elements
000	1x	1xxxx	10xxxx	SVE Permute Vector - Predicated
000	1x	1xxxx	11xxxx	SEL (vectors)
000	10	1xxxx	000xxx	SVE Permute Vector - Extract
000	11	1xxxx	000xxx	UNALLOCATED
001	0x	0xxxx		SVE Integer Compare - Vectors
001	0x	1xxxx		SVE integer compare with unsigned immediate
001	1x	0xxxx	x0xxxx	SVE integer compare with signed immediate
001	1x	00xxx	01xxxx	SVE predicate logical operations
001	1x	00xxx	11xxxx	SVE Propagate Break
001	1x	01xxx	01xxxx	SVE Partition Break
001	1x	01xxx	11xxxx	SVE Predicate Misc
001	1x	1xxxx	00xxxx	SVE Integer Compare - Scalars
001	1x	1xxxx	01xxxx	UNALLOCATED
001	1x	1xxxx	11xxxx	SVE Integer Wide Immediate - Unpredicated
001	1x	100xx	10xxxx	SVE predicate count
001	1x	101xx	1000xx	SVE Inc/Dec by Predicate Count
001	1x	101xx	1001xx	SVE Write FFR
001	1x	101xx	101xxx	UNALLOCATED
001	1x	11xxx	10xxxx	UNALLOCATED
010	0x	0xxxx	0xxxxx	SVE Integer Multiply-Add - Unpredicated
010	0x	0xxxx	10xxxx	SVE2 Integer - Predicated
010	0x	0xxxx	11xxxx	UNALLOCATED
010	0x	1xxxx		SVE Multiply - Indexed
010	1x	0xxxx	0xxxxx	SVE2 Widening Integer Arithmetic
010	1x	0xxxx	10xxxx	SVE2 Misc
010	1x	0xxxx	11xxxx	SVE2 Accumulate
010	1x	1xxxx	0xxxxx	SVE2 Narrowing
010	1x	1xxxx	100xxx	SVE2 character match
010	1x	1xxxx	101xxx	SVE2 Histogram Computation - Segment
010	1x	1xxxx	110xxx	HISTCNT
010	1x	1xxxx	111xxx	SVE2 Crypto Extensions
011	0x	0xxxx	0xxxxx	FCMLA (vectors)
011	0x	00x1x	1xxxxx	UNALLOCATED
011	0x	00000	100xxx	FCADD
011	0x	00000	101xxx	UNALLOCATED
011	0x	00000	11xxxx	UNALLOCATED
011	0x	00001	1xxxxx	UNALLOCATED
011	0x	0010x	100xxx	UNALLOCATED
011	0x	0010x	101xxx	SVE2 floating-point convert precision
011	0x	0010x	11xxxx	UNALLOCATED
011	0x	010xx	100xxx	SVE2 floating-point pairwise operations

011	0x	010xx	101xxx	UNALLOCATED
011	0x	010xx	11xxxx	UNALLOCATED
011	0x	011xx	1xxxxx	UNALLOCATED
011	0x	1xxxx	x0x01x	UNALLOCATED
011	0x	1xxxx	00000x	SVE floating-point multiply-add (indexed)
011	0x	1xxxx	0001xx	SVE floating-point complex multiply-add (indexed)
011	0x	1xxxx	001000	SVE floating-point multiply (indexed)
011	0x	1xxxx	001001	UNALLOCATED
011	0x	1xxxx	0011xx	UNALLOCATED
011	0x	1xxxx	01x0xx	SVE2 Floating Point Widening Multiply-Add - Indexed
011	0x	1xxxx	01x1xx	UNALLOCATED
011	0x	1xxxx	10x00x	SVE2 Floating Point Widening Multiply-Add
011	0x	1xxxx	10x1xx	UNALLOCATED
011	0x	1xxxx	11xxxx	UNALLOCATED
011	1x	0xxxx	x1xxxx	SVE floating-point compare vectors
011	1x	0xxxx	000xxx	SVE floating-point arithmetic (unpredicated)
011	1x	0xxxx	100xxx	SVE Floating Point Arithmetic - Predicated
011	1x	0xxxx	101xxx	SVE Floating Point Unary Operations - Predicated
011	1x	000xx	001xxx	SVE floating-point recursive reduction
011	1x	001xx	0010xx	UNALLOCATED
011	1x	001xx	0011xx	SVE Floating Point Unary Operations - Unpredicated
011	1x	010xx	001xxx	SVE Floating Point Compare - with Zero
011	1x	011xx	001xxx	SVE floating-point serial reduction (predicated)
011	1x	1xxxx		SVE Floating Point Multiply-Add
100				SVE Memory - 32-bit Gather and Unsized Contiguous
101				SVE Memory - Contiguous Load
110				SVE Memory - 64-bit Gather
111				SVE Memory - Store

SVE Integer Multiply-Add - Predicated

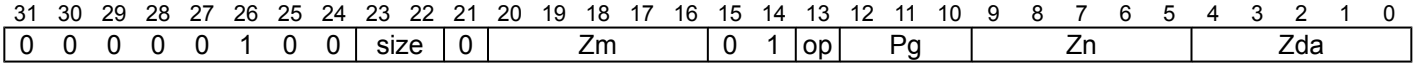
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	SVE integer multiply-accumulate writing addend (predicated)
1	SVE integer multiply-add writing multiplicand (predicated)

SVE integer multiply-accumulate writing addend (predicated)

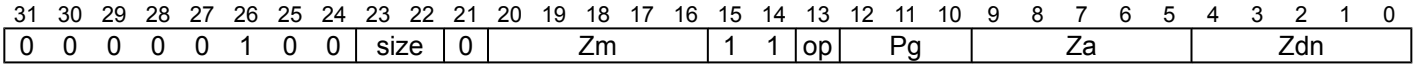
These instructions are under SVE Integer Multiply-Add - Predicated.



Decode fields op	Instruction Details
0	MLA (vectors)
1	MLS (vectors)

SVE integer multiply-add writing multiplicand (predicated)

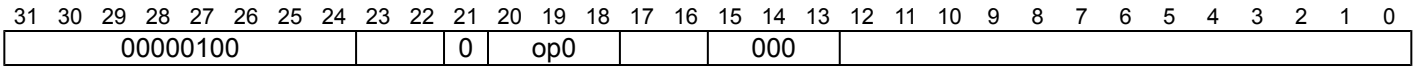
These instructions are under SVE Integer Multiply-Add - Predicated.



Decode fields op	Instruction Details
0	MAD
1	MSB

SVE Integer Binary Arithmetic - Predicated

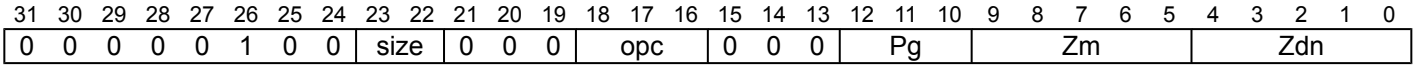
These instructions are under SVE encodings.



Decode fields op0	Instruction details
00x	SVE integer add/subtract vectors (predicated)
01x	SVE integer min/max/difference (predicated)
100	SVE integer multiply vectors (predicated)
101	SVE integer divide vectors (predicated)
11x	SVE bitwise logical operations (predicated)

SVE integer add/subtract vectors (predicated)

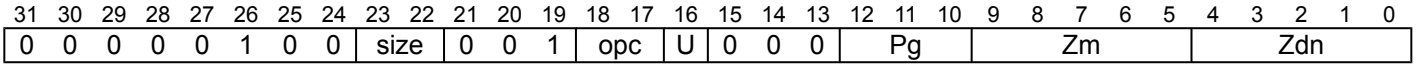
These instructions are under SVE Integer Binary Arithmetic - Predicated.



Decode fields opc	Instruction Details
000	ADD (vectors, predicated)
001	SUB (vectors, predicated)
010	UNALLOCATED
011	SUBR (vectors)
1xx	UNALLOCATED

SVE integer min/max/difference (predicated)

These instructions are under SVE Integer Binary Arithmetic - Predicated.



Decode fields opc	U	Instruction Details
00	0	SMAX (vectors)
00	1	UMAX (vectors)
01	0	SMIN (vectors)
01	1	UMIN (vectors)

Decode fields opc	U	Instruction Details
10	0	SABD
10	1	UABD
11		UNALLOCATED

SVE integer multiply vectors (predicated)

These instructions are under SVE Integer Binary Arithmetic - Predicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	0	0	H	U	0	0	0	Pg			Zm					Zdn				

Decode fields H	U	Instruction Details
0	0	MUL (vectors, predicated)
0	1	UNALLOCATED
1	0	SMULH (predicated)
1	1	UMULH (predicated)

SVE integer divide vectors (predicated)

These instructions are under SVE Integer Binary Arithmetic - Predicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	0	1	R	U	0	0	0	Pg			Zm					Zdn				

Decode fields R	U	Instruction Details
0	0	SDIV
0	1	UDIV
1	0	SDIVR
1	1	UDIVR

SVE bitwise logical operations (predicated)

These instructions are under SVE Integer Binary Arithmetic - Predicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	1	opc			0	0	0	Pg			Zm					Zdn				

Decode fields opc	Instruction Details
000	ORR (vectors, predicated)
001	EOR (vectors, predicated)
010	AND (vectors, predicated)
011	BIC (vectors, predicated)
1xx	UNALLOCATED

SVE Integer Reduction

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00000100										0	op0					001															

Decode fields op0	Instruction details
00	SVE integer add reduction (predicated)
01	SVE integer min/max reduction (predicated)
10	SVE constructive prefix (predicated)
11	SVE bitwise logical reduction (predicated)

SVE integer add reduction (predicated)

These instructions are under SVE Integer Reduction.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	0	0	opc		U	0	0	1	Pg			Zn					Vd				

Decode fields opc	U	Instruction Details
00	0	SADDV
00	1	UADDV
01		UNALLOCATED
1x		UNALLOCATED

SVE integer min/max reduction (predicated)

These instructions are under SVE Integer Reduction.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	0	1	opc		U	0	0	1	Pg			Zn					Vd				

Decode fields opc	U	Instruction Details
00	0	SMAXV
00	1	UMAXV
01	0	SMINV
01	1	UMINV
1x		UNALLOCATED

SVE constructive prefix (predicated)

These instructions are under SVE Integer Reduction.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	0	opc		M	0	0	1	Pg			Zn					Zd				

Decode fields opc	Instruction Details
00	MOVPRFX (predicated)
01	UNALLOCATED
1x	UNALLOCATED

SVE bitwise logical reduction (predicated)

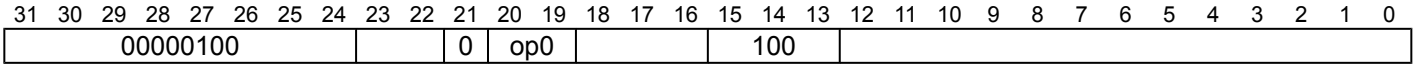
These instructions are under SVE Integer Reduction.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	1	opc			0	0	1	Pg			Zn					Vd				

Decode fields opc	Instruction Details
000	ORV
001	EORV
010	ANDV
011	UNALLOCATED
1xx	UNALLOCATED

SVE Bitwise Shift - Predicated

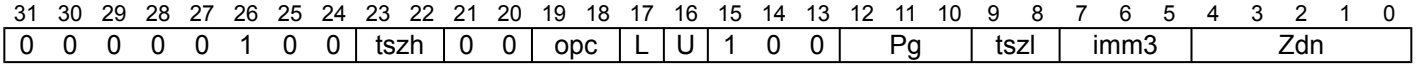
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0x	SVE bitwise shift by immediate (predicated)
10	SVE bitwise shift by vector (predicated)
11	SVE bitwise shift by wide elements (predicated)

SVE bitwise shift by immediate (predicated)

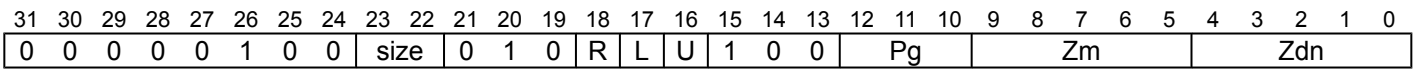
These instructions are under SVE Bitwise Shift - Predicated.



Decode fields opc	L	U	Instruction Details
00	0	0	ASR (immediate, predicated)
00	0	1	LSR (immediate, predicated)
00	1	0	UNALLOCATED
00	1	1	LSL (immediate, predicated)
01	0	0	ASRD
01	0	1	UNALLOCATED
01	1	0	SQSHL (immediate)
01	1	1	UQSHL (immediate)
10			UNALLOCATED
11	0	0	SRSHR
11	0	1	URSHR
11	1	0	UNALLOCATED
11	1	1	SQSHLU

SVE bitwise shift by vector (predicated)

These instructions are under SVE Bitwise Shift - Predicated.



Decode fields R	L	U	Instruction Details
	1	0	UNALLOCATED

Decode fields R	L	U	Instruction Details
0	0	0	ASR (vectors)
0	0	1	LSR (vectors)
0	1	1	LSL (vectors)
1	0	0	ASRR
1	0	1	LSRR
1	1	1	LSLR

SVE bitwise shift by wide elements (predicated)

These instructions are under SVE Bitwise Shift - Predicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	1	R	L	U	1	0	0	Pg			Zm					Zdn				

Decode fields R	L	U	Instruction Details
0	0	0	ASR (wide elements, predicated)
0	0	1	LSR (wide elements, predicated)
0	1	0	UNALLOCATED
0	1	1	LSL (wide elements, predicated)
1			UNALLOCATED

SVE Integer Unary Arithmetic - Predicated

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00000100										0	op0					101															

Decode fields op0	Instruction details
0x	UNALLOCATED
10	SVE integer unary operations (predicated)
11	SVE bitwise unary operations (predicated)

SVE integer unary operations (predicated)

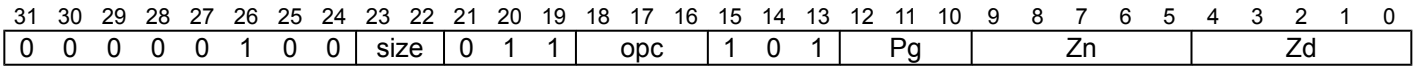
These instructions are under SVE Integer Unary Arithmetic - Predicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		0	1	0	opc			1	0	1	Pg			Zn					Zd				

Decode fields opc	Instruction Details
000	SXTB, SXTH, SXTW — SXTB
001	UXTB, UXTH, UXTW — UXTB
010	SXTB, SXTH, SXTW — SXTH
011	UXTB, UXTH, UXTW — UXTH
100	SXTB, SXTH, SXTW — SXTW
101	UXTB, UXTH, UXTW — UXTW
110	ABS
111	NEG

SVE bitwise unary operations (predicated)

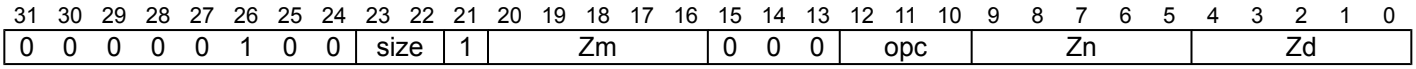
These instructions are under SVE Integer Unary Arithmetic - Predicated.



Decode fields opc	Instruction Details
000	CLS
001	CLZ
010	CNT
011	CNOT
100	FABS
101	FNEG
110	NOT (vector)
111	UNALLOCATED

SVE integer add/subtract vectors (unpredicated)

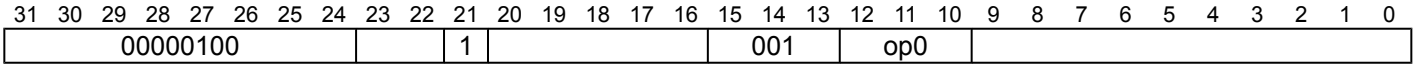
These instructions are under SVE encodings.



Decode fields opc	Instruction Details
000	ADD (vectors, unpredicated)
001	SUB (vectors, unpredicated)
01x	UNALLOCATED
100	SQADD (vectors, unpredicated)
101	UQADD (vectors, unpredicated)
110	SQSUB (vectors, unpredicated)
111	UQSUB (vectors, unpredicated)

SVE Bitwise Logical - Unpredicated

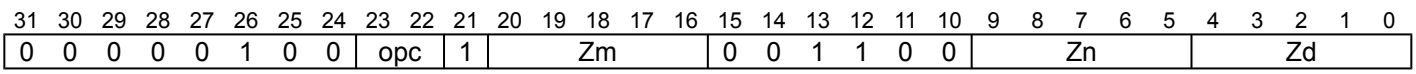
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0xx	UNALLOCATED
100	SVE bitwise logical operations (unpredicated)
101	XAR
11x	SVE2 bitwise ternary operations

SVE bitwise logical operations (unpredicated)

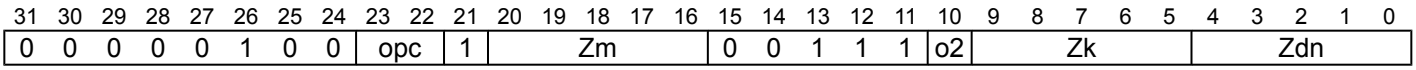
These instructions are under SVE Bitwise Logical - Unpredicated.



Decode fields opc	Instruction Details
00	AND (vectors, unpredicated)
01	ORR (vectors, unpredicated)
10	EOR (vectors, unpredicated)
11	BIC (vectors, unpredicated)

SVE2 bitwise ternary operations

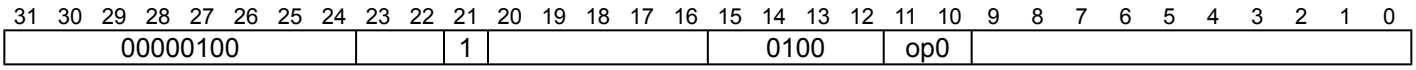
These instructions are under SVE Bitwise Logical - Unpredicated.



Decode fields opc	o2	Instruction Details
00	0	EOR3
00	1	BSL
01	0	BCAX
01	1	BSL1N
1x	0	UNALLOCATED
10	1	BSL2N
11	1	NBSL

SVE Index Generation

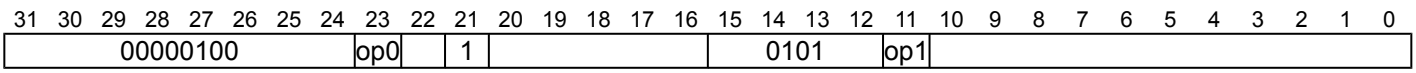
These instructions are under SVE encodings.



Decode fields op0	Instruction details
00	INDEX (immediates)
01	INDEX (scalar, immediate)
10	INDEX (immediate, scalar)
11	INDEX (scalars)

SVE Stack Allocation

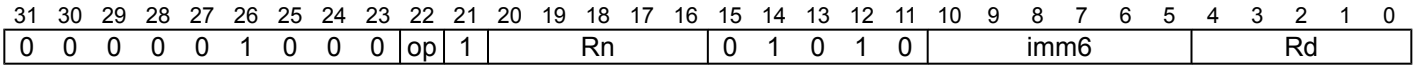
These instructions are under SVE encodings.



Decode fields op0	op1	Instruction details
0	0	SVE stack frame adjustment
1	0	SVE stack frame size
	1	UNALLOCATED

SVE stack frame adjustment

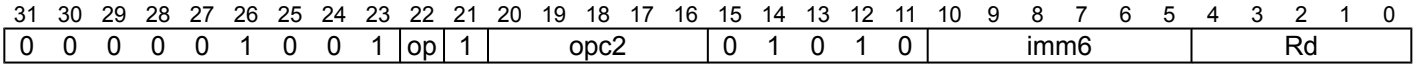
These instructions are under SVE Stack Allocation.



Decode fields op	Instruction Details
0	ADDVL
1	ADDPL

SVE stack frame size

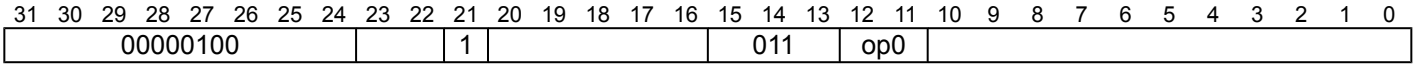
These instructions are under SVE Stack Allocation.



Decode fields op	opc2	Instruction Details
0	0xxxx	UNALLOCATED
0	10xxx	UNALLOCATED
0	110xx	UNALLOCATED
0	1110x	UNALLOCATED
0	11110	UNALLOCATED
0	11111	RDVL
1		UNALLOCATED

SVE2 Integer Multiply - Unpredicated

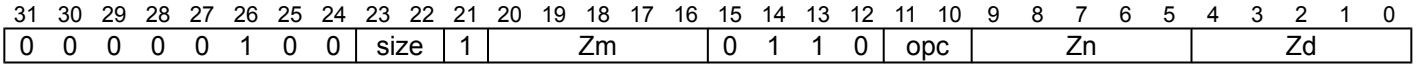
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0x	SVE2 integer multiply vectors (unpredicated)
10	SVE2 signed saturating doubling multiply high (unpredicated)
11	UNALLOCATED

SVE2 integer multiply vectors (unpredicated)

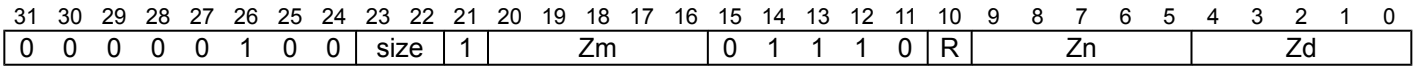
These instructions are under SVE2 Integer Multiply - Unpredicated.



Decode fields size	opc	Instruction Details
	00	MUL (vectors, unpredicated)
	10	SMULH (unpredicated)
	11	UMULH (unpredicated)
00	01	PMUL
01	01	UNALLOCATED
1x	01	UNALLOCATED

SVE2 signed saturating doubling multiply high (unpredicated)

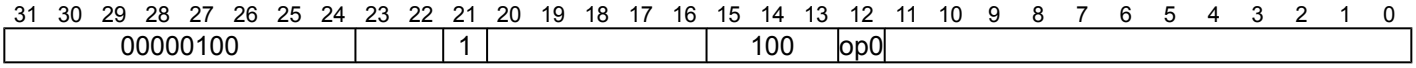
These instructions are under SVE2 Integer Multiply - Unpredicated.



Decode fields R	Instruction Details
0	SQDMULH (vectors)
1	SQRDMULH (vectors)

SVE Bitwise Shift - Unpredicated

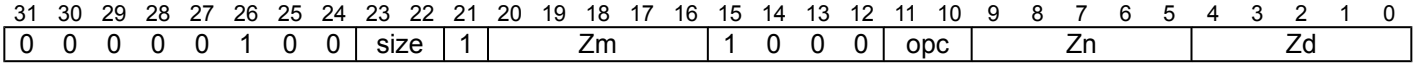
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	SVE bitwise shift by wide elements (unpredicated)
1	SVE bitwise shift by immediate (unpredicated)

SVE bitwise shift by wide elements (unpredicated)

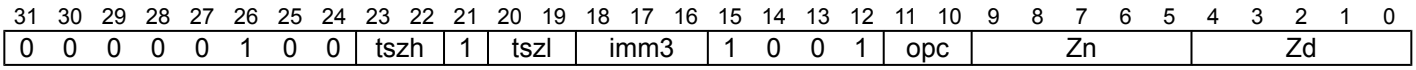
These instructions are under SVE Bitwise Shift - Unpredicated.



Decode fields opc	Instruction Details
00	ASR (wide elements, unpredicated)
01	LSR (wide elements, unpredicated)
10	UNALLOCATED
11	LSL (wide elements, unpredicated)

SVE bitwise shift by immediate (unpredicated)

These instructions are under SVE Bitwise Shift - Unpredicated.



Decode fields opc	Instruction Details
00	ASR (immediate, unpredicated)
01	LSR (immediate, unpredicated)
10	UNALLOCATED
11	LSL (immediate, unpredicated)

SVE address generation

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	opc		1	Zm					1	0	1	0	msz		Zn					Zd				

Decode fields opc	Instruction Details
00	ADR — Unpacked 32-bit signed offsets
01	ADR — Unpacked 32-bit unsigned offsets
1x	ADR — Packed offsets

SVE Integer Misc - Unpredicated

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00000100										1						1011				op0											

Decode fields op0	Instruction details
0x	SVE floating-point trig select coefficient
10	SVE floating-point exponential accelerator
11	SVE constructive prefix (unpredicated)

SVE floating-point trig select coefficient

These instructions are under SVE Integer Misc - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		1	Zm					1	0	1	1	0	op	Zn					Zd				

Decode fields op	Instruction Details
0	FTSSEL
1	UNALLOCATED

SVE floating-point exponential accelerator

These instructions are under SVE Integer Misc - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	size		1	opc					1	0	1	1	1	0	Zn					Zd				

Decode fields opc	Instruction Details
00000	FEXPA
00001	UNALLOCATED
0001x	UNALLOCATED
001xx	UNALLOCATED
01xxx	UNALLOCATED
1xxxx	UNALLOCATED

SVE constructive prefix (unpredicated)

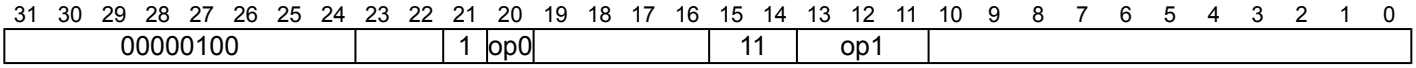
These instructions are under SVE Integer Misc - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	opc		1	opc2					1	0	1	1	1	1	Zn					Zd				

Decode fields opc	opc2	Instruction Details
00	00000	MOVPRFX (unpredicated)
00	00001	UNALLOCATED
00	0001x	UNALLOCATED
00	001xx	UNALLOCATED
00	01xxx	UNALLOCATED
00	1xxxx	UNALLOCATED
01		UNALLOCATED
1x		UNALLOCATED

SVE Element Count

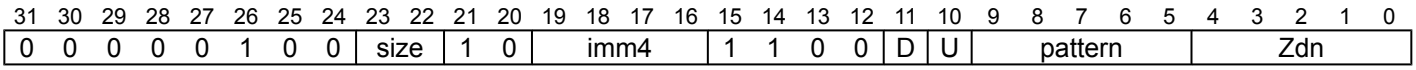
These instructions are under SVE encodings.



Decode fields op0	op1	Instruction details
0	00x	SVE saturating inc/dec vector by element count
0	100	SVE element count
0	101	UNALLOCATED
1	000	SVE inc/dec vector by element count
1	100	SVE inc/dec register by element count
1	x01	UNALLOCATED
	01x	UNALLOCATED
	11x	SVE saturating inc/dec register by element count

SVE saturating inc/dec vector by element count

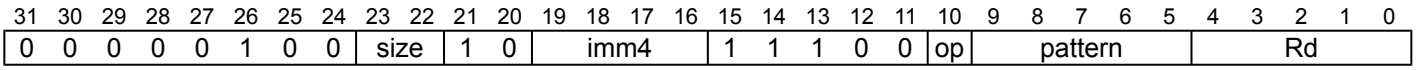
These instructions are under SVE Element Count.



Decode fields size	D	U	Instruction Details
00			UNALLOCATED
01	0	0	SQINCH (vector)
01	0	1	UQINCH (vector)
01	1	0	SQDECH (vector)
01	1	1	UQDECH (vector)
10	0	0	SQINCW (vector)
10	0	1	UQINCW (vector)
10	1	0	SQDECW (vector)
10	1	1	UQDECW (vector)
11	0	0	SQINCD (vector)
11	0	1	UQINCD (vector)
11	1	0	SQDECD (vector)
11	1	1	UQDECD (vector)

SVE element count

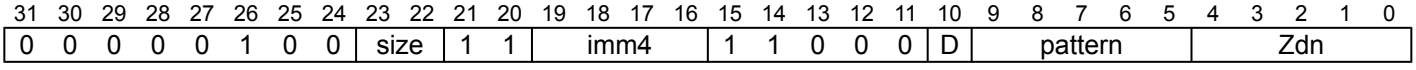
These instructions are under SVE Element Count.



Decode fields size	op	Instruction Details
	1	UNALLOCATED
00	0	CNTB, CNTD, CNTH, CNTW — CNTB
01	0	CNTB, CNTD, CNTH, CNTW — CNTH
10	0	CNTB, CNTD, CNTH, CNTW — CNTW
11	0	CNTB, CNTD, CNTH, CNTW — CNTD

SVE inc/dec vector by element count

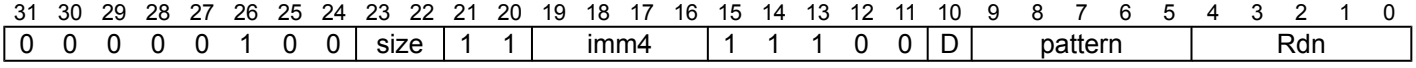
These instructions are under SVE Element Count.



Decode fields size	D	Instruction Details
00		UNALLOCATED
01	0	INCD, INCH, INCW (vector) — INCH
01	1	DECD, DECH, DECW (vector) — DECH
10	0	INCD, INCH, INCW (vector) — INCW
10	1	DECD, DECH, DECW (vector) — DECW
11	0	INCD, INCH, INCW (vector) — INCD
11	1	DECD, DECH, DECW (vector) — DECD

SVE inc/dec register by element count

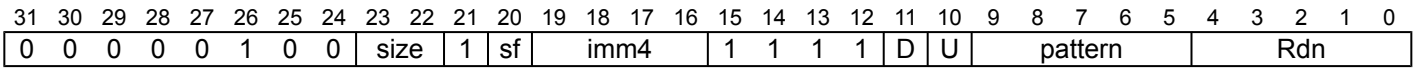
These instructions are under SVE Element Count.



Decode fields size	D	Instruction Details
00	0	INCB, INCD, INCH, INCW (scalar) — INCB
00	1	DECB, DECD, DECH, DECW (scalar) — DECB
01	0	INCB, INCD, INCH, INCW (scalar) — INCH
01	1	DECB, DECD, DECH, DECW (scalar) — DECH
10	0	INCB, INCD, INCH, INCW (scalar) — INCW
10	1	DECB, DECD, DECH, DECW (scalar) — DECW
11	0	INCB, INCD, INCH, INCW (scalar) — INCD
11	1	DECB, DECD, DECH, DECW (scalar) — DECD

SVE saturating inc/dec register by element count

These instructions are under SVE Element Count.



Decode fields size	sf	D	U	Instruction Details
00	0	0	0	SQINCB — 32-bit
00	0	0	1	UQINCB — 32-bit
00	0	1	0	SQDECB — 32-bit
00	0	1	1	UQDECB — 32-bit
00	1	0	0	SQINCB — 64-bit
00	1	0	1	UQINCB — 64-bit
00	1	1	0	SQDECB — 64-bit
00	1	1	1	UQDECB — 64-bit
01	0	0	0	SQINCH (scalar) — 32-bit
01	0	0	1	UQINCH (scalar) — 32-bit
01	0	1	0	SQDECH (scalar) — 32-bit
01	0	1	1	UQDECH (scalar) — 32-bit
01	1	0	0	SQINCH (scalar) — 64-bit
01	1	0	1	UQINCH (scalar) — 64-bit
01	1	1	0	SQDECH (scalar) — 64-bit
01	1	1	1	UQDECH (scalar) — 64-bit
10	0	0	0	SQINCW (scalar) — 32-bit
10	0	0	1	UQINCW (scalar) — 32-bit
10	0	1	0	SQDECW (scalar) — 32-bit
10	0	1	1	UQDECW (scalar) — 32-bit
10	1	0	0	SQINCW (scalar) — 64-bit
10	1	0	1	UQINCW (scalar) — 64-bit
10	1	1	0	SQDECW (scalar) — 64-bit
10	1	1	1	UQDECW (scalar) — 64-bit
11	0	0	0	SQINCD (scalar) — 32-bit
11	0	0	1	UQINCD (scalar) — 32-bit
11	0	1	0	SQDECD (scalar) — 32-bit
11	0	1	1	UQDECD (scalar) — 32-bit
11	1	0	0	SQINCD (scalar) — 64-bit
11	1	0	1	UQINCD (scalar) — 64-bit
11	1	1	0	SQDECD (scalar) — 64-bit
11	1	1	1	UQDECD (scalar) — 64-bit

SVE Bitwise Immediate

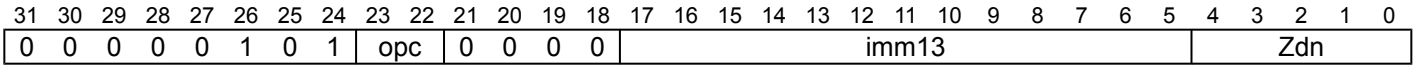
These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00000101										00		op0																			

Decode fields op0	Instruction details
00	SVE bitwise logical with immediate (unpredicated)
!= 00	UNALLOCATED

SVE bitwise logical with immediate (unpredicated)

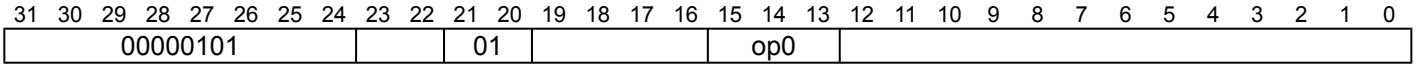
These instructions are under SVE Bitwise Immediate.



Decode fields opc	Instruction Details
00	ORR (immediate)
01	EOR (immediate)
10	AND (immediate)

SVE Integer Wide Immediate - Predicated

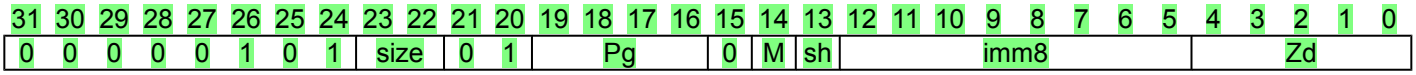
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0xx	SVE copy integer immediate (predicated)~~CPY (immediate)~~
10x	UNALLOCATED
110	FCPY
111	UNALLOCATED

SVE copy integer immediate (predicated)

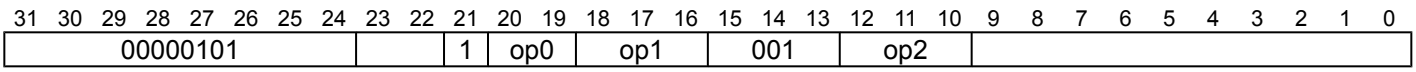
These instructions are under SVE Integer Wide Immediate - Predicated.



Decode fields M	Instruction Details
0	CPY (immediate, zeroing)
1	CPY (immediate, merging)

SVE Permute Vector - Unpredicated

These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
00	000	110	DUP (scalar)
~~000~~	~~00~~	~~110~~	~~DUP (scalar)~~
00	100	110	INSR (scalar)
~~001~~	~~00~~	~~110~~	~~INSR (scalar)~~
00	x00	001	UNALLOCATED
~~00x~~	~~00~~	~~001~~	~~UNALLOCATED~~
00	x00	1x1	UNALLOCATED
~~00x~~	~~00~~	~~1x1~~	~~UNALLOCATED~~
00~~00x~~	x != 00	11x	UNALLOCATED
00~~00x~~	x != 00	x01	UNALLOCATED
01~~01x~~		11x	UNALLOCATED

01~~01x~~		x01	UNALLOCATED
10~~100~~	0xx	001	UNALLOCATED
10~~100~~	0xx	110	SVE unpack vector elements
10~~100~~	0xx	1x1	UNALLOCATED
10~~101~~	10000	001	UNALLOCATED
10~~101~~	10000	110	INSR (SIMD&FP scalar)
10~~101~~	10000	1x1	UNALLOCATED
10~~101~~	1!= 00	11x	UNALLOCATED
10~~101~~	1!= 00	x01	UNALLOCATED
11~~110~~	00000	001	UNALLOCATED
11~~110~~	00000	110	REV (vector)
11~~110~~	00000	1x1	UNALLOCATED
11~~110~~	0!= 00	x01~~11x~~	UNALLOCATED
11~~110~~	1xx~~!= 00~~	001~~x01~~	UNALLOCATED
11~~111~~	1xx	101	UNALLOCATED
11	!= 000	11x~~000~~	~~DUP (indexed)~~UNALLOCATED
		00001~~x~~	DUP (indexed)~~SVE table lookup (three sources)~~
		01x~~100~~	~~— SVE~~SVE table lookup (three sources)~~TBL~~
		100	TBL — SVE

SVE unpack vector elements

These instructions are under SVE Permute Vector - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	size		1	1	0	0	U		H	0	0	1	1	1	0	Zn					Zd			

Decode fields U	H	Instruction Details
0	0	SUNPKHI, SUNPKLO — SUNPKLO
0	1	SUNPKHI, SUNPKLO — SUNPKHI
1	0	UUNPKHI, UUNPKLO — UUNPKLO
1	1	UUNPKHI, UUNPKLO — UUNPKHI

SVE table lookup (three sources)

These instructions are under SVE Permute Vector - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	size		1	Zm					0	0	1	0	1	op		Zn					Zd			

Decode fields op	Instruction Details
0	TBL
1	TBX

SVE Permute Predicate

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00000101								op0		1	op1					010			op2								op3				

Decode fields op0	op1	op2	op3	Instruction details
00	1000x	0000	0	SVE unpack predicate elements
01	1000x	0000	0	UNALLOCATED
10	1000x	0000	0	UNALLOCATED
11	1000x	0000	0	UNALLOCATED
	0xxxx	xxx0	0	SVE permute predicate elements
	0xxxx	xxx1	0	UNALLOCATED
	10100	0000	0	REV (predicate)
	10101	0000	0	UNALLOCATED
	10x0x	1000	0	UNALLOCATED
	10x0x	x100	0	UNALLOCATED
	10x0x	xx10	0	UNALLOCATED
	10x0x	xxx1	0	UNALLOCATED
	10x1x		0	UNALLOCATED
	11xxx		0	UNALLOCATED
			1	UNALLOCATED

SVE unpack predicate elements

These instructions are under SVE Permute Predicate.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	H	0	1	0	0	0	0	0	Pn				0	Pd			

Decode fields H	Instruction Details
0	PUNPKHI, PUNPKLO — PUNPKLO
1	PUNPKHI, PUNPKLO — PUNPKHI

SVE permute predicate elements

These instructions are under SVE Permute Predicate.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	size		1	0	Pm				0	1	0	opc		H	0	Pn				0	Pd			

Decode fields opc	H	Instruction Details
00	0	ZIP1, ZIP2 (predicates) — ZIP1
00	1	ZIP1, ZIP2 (predicates) — ZIP2
01	0	UZP1, UZP2 (predicates) — UZP1
01	1	UZP1, UZP2 (predicates) — UZP2
10	0	TRN1, TRN2 (predicates) — TRN1
10	1	TRN1, TRN2 (predicates) — TRN2
11		UNALLOCATED

SVE permute vector elements

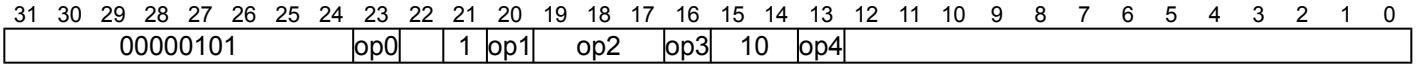
These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	size		1	Zm					0	1	1	opc			Zn					Zd				

Decode fields opc	Instruction Details
000	ZIP1, ZIP2 (vectors) — ZIP1
001	ZIP1, ZIP2 (vectors) — ZIP2
010	UZP1, UZP2 (vectors) — UZP1
011	UZP1, UZP2 (vectors) — UZP2
100	TRN1, TRN2 (vectors) — TRN1
101	TRN1, TRN2 (vectors) — TRN2
11x	UNALLOCATED

SVE Permute Vector - Predicated

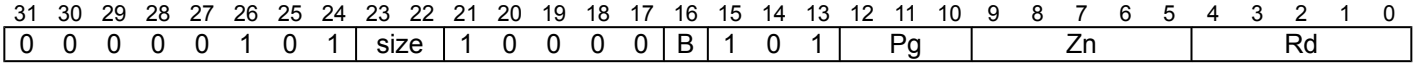
These instructions are under SVE encodings.



Decode fields op0	op1	op2	op3	op4	Instruction details
0	0	000	1	0	UNALLOCATED
1	0	000	1	0	COMPACT
	0	000	0	0	CPY (SIMD&FP scalar)
	0	000		1	SVE extract element to general register
	0	001		0	SVE extract element to SIMD&FP scalar register
	0	01x		0	SVE reverse within elements
	0	01x		1	UNALLOCATED
	0	100	0	1	CPY (scalar)
	0	100	1	1	UNALLOCATED
	0	100		0	SVE conditionally broadcast element to vector
	0	101		0	SVE conditionally extract element to SIMD&FP scalar
	0	110	0	0	SPLICE — Destructive
	0	110	1	0	SPLICE — Constructive
	0	110		1	UNALLOCATED
	0	111	0		UNALLOCATED
	0	111	1		UNALLOCATED
	~~0~~	~~x01~~		~~1~~	~~UNALLOCATED~~
	0	x01		1	UNALLOCATED
	~~1~~	~~000~~		~~0~~	~~UNALLOCATED~~
	1	000		0~~1~~	~~SVE conditionally extract element to general register~~UNALLOCATED
	1	000		1	SVE conditionally extract element to general register
	~~1~~	~~!= 000~~			~~UNALLOCATED~~
	1	!= 000			UNALLOCATED

SVE extract element to general register

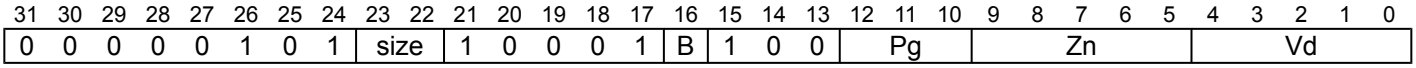
These instructions are under SVE Permute Vector - Predicated.



Decode fields B	Instruction Details
0	LASTA (scalar)
1	LASTB (scalar)

SVE extract element to SIMD&FP scalar register

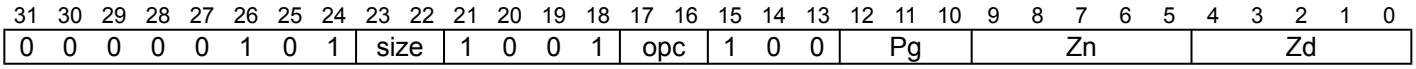
These instructions are under SVE Permute Vector - Predicated.



Decode fields B	Instruction Details
0	LASTA (SIMD&FP scalar)
1	LASTB (SIMD&FP scalar)

SVE reverse within elements

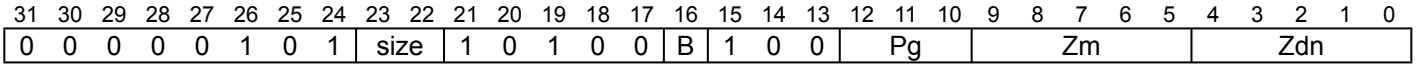
These instructions are under SVE Permute Vector - Predicated.



Decode fields opc	Instruction Details
00	REVB, REVH, REVW — REVB
01	REVB, REVH, REVW — REVH
10	REVB, REVH, REVW — REVW
11	RBIT

SVE conditionally broadcast element to vector

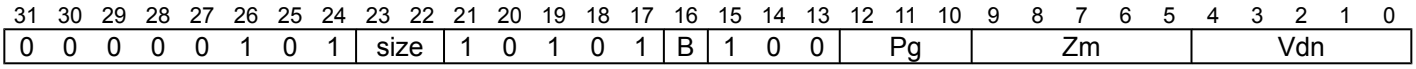
These instructions are under SVE Permute Vector - Predicated.



Decode fields B	Instruction Details
0	CLASTA (vectors)
1	CLASTB (vectors)

SVE conditionally extract element to SIMD&FP scalar

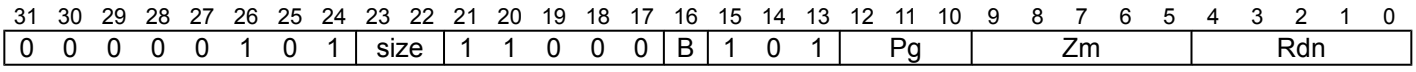
These instructions are under SVE Permute Vector - Predicated.



Decode fields B	Instruction Details
0	CLASTA (SIMD&FP scalar)
1	CLASTB (SIMD&FP scalar)

SVE conditionally extract element to general register

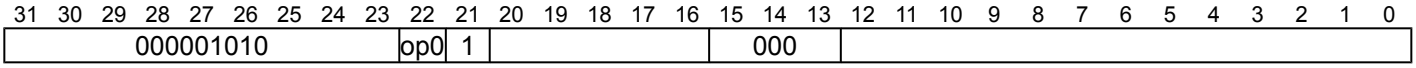
These instructions are under SVE Permute Vector - Predicated.



Decode fields B	Instruction Details
0	CLASTA (scalar)
1	CLASTB (scalar)

SVE Permute Vector - Extract

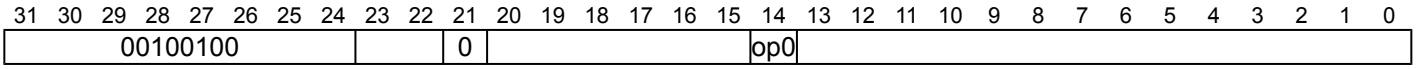
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	EXT — Destructive
1	EXT — Constructive

SVE Integer Compare - Vectors

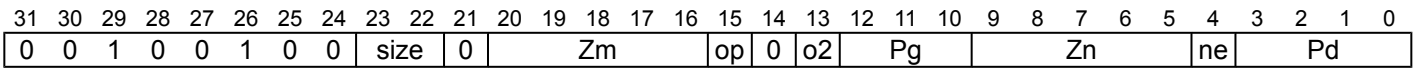
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	SVE integer compare vectors
1	SVE integer compare with wide elements

SVE integer compare vectors

These instructions are under SVE Integer Compare - Vectors.



Decode fields op	o2	ne	Instruction Details
0	0	0	CMP<cc> (vectors) — CMPHS
0	0	1	CMP<cc> (vectors) — CMPHI
0	1	0	CMP<cc> (wide elements) — CMPEQ
0	1	1	CMP<cc> (wide elements) — CMPNE
1	0	0	CMP<cc> (vectors) — CMPGE
1	0	1	CMP<cc> (vectors) — CMPGT
1	1	0	CMP<cc> (vectors) — CMPEQ
1	1	1	CMP<cc> (vectors) — CMPNE

SVE integer compare with wide elements

These instructions are under SVE Integer Compare - Vectors.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	0	size		0	Zm					U	1	lt	Pg			Zn					ne	Pd			

Decode fields U	lt	ne	Instruction Details
0	0	0	CMP<cc> (wide elements) — CMPGE
0	0	1	CMP<cc> (wide elements) — CMPGT
0	1	0	CMP<cc> (wide elements) — CMPLT
0	1	1	CMP<cc> (wide elements) — CMPLE
1	0	0	CMP<cc> (wide elements) — CMPHS
1	0	1	CMP<cc> (wide elements) — CMPHI
1	1	0	CMP<cc> (wide elements) — CMPLO
1	1	1	CMP<cc> (wide elements) — CMPLS

SVE integer compare with unsigned immediate

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	0	size		1	imm7							lt	Pg			Zn					ne	Pd			

Decode fields lt	ne	Instruction Details
0	0	CMP<cc> (immediate) — CMPHS
0	1	CMP<cc> (immediate) — CMPHI
1	0	CMP<cc> (immediate) — CMPLO
1	1	CMP<cc> (immediate) — CMPLS

SVE integer compare with signed immediate

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		0	imm5					op	0	o2	Pg			Zn					ne	Pd			

Decode fields op	o2	ne	Instruction Details
0	0	0	CMP<cc> (immediate) — CMPGE
0	0	1	CMP<cc> (immediate) — CMPGT
0	1	0	CMP<cc> (immediate) — CMPLT
0	1	1	CMP<cc> (immediate) — CMPLE
1	0	0	CMP<cc> (immediate) — CMPEQ
1	0	1	CMP<cc> (immediate) — CMPNE
1	1		UNALLOCATED

SVE predicate logical operations

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	op		S	0	0	Pm				0	1	Pg			o2	Pn				o3	Pd			

Decode fields				Instruction Details
op	S	o2	o3	
0	0	0	0	AND, ANDS (predicates) — not setting the condition flags
0	0	0	1	BIC, BICS (predicates) — not setting the condition flags
0	0	1	0	EOR, EORS (predicates) — not setting the condition flags
0	0	1	1	SEL (predicates)
0	1	0	0	AND, ANDS (predicates) — setting the condition flags
0	1	0	1	BIC, BICS (predicates) — setting the condition flags
0	1	1	0	EOR, EORS (predicates) — setting the condition flags
0	1	1	1	UNALLOCATED
1	0	0	0	ORR, ORRS (predicates) — not setting the condition flags
1	0	0	1	ORN, ORNS (predicates) — not setting the condition flags
1	0	1	0	NOR, NORS — not setting the condition flags
1	0	1	1	NAND, NANDS — not setting the condition flags
1	1	0	0	ORR, ORRS (predicates) — setting the condition flags
1	1	0	1	ORN, ORNS (predicates) — setting the condition flags
1	1	1	0	NOR, NORS — setting the condition flags
1	1	1	1	NAND, NANDS — setting the condition flags

SVE Propagate Break

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00100101										00						11						op0									

Decode fields	Instruction details
op0	
0	SVE propagate break from previous partition
1	UNALLOCATED

SVE propagate break from previous partition

These instructions are under SVE Propagate Break.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	op	S	0	0	Pm				1	1	Pg				0	Pn				B	Pd			

Decode fields			Instruction Details
op	S	B	
0	0	0	BRKPA, BRKPAS — not setting the condition flags
0	0	1	BRKPB, BRKPBS — not setting the condition flags
0	1	0	BRKPA, BRKPAS — setting the condition flags
0	1	1	BRKPB, BRKPBS — setting the condition flags
1			UNALLOCATED

SVE Partition Break

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00100101								op0		01		op1				01						op2					op3				

Decode fields op0	op1	op2	op3	Instruction details
0	1000	0	0	SVE propagate break to next partition
0	1000	0	1	UNALLOCATED
0	x000	1		UNALLOCATED
0	x1xx			UNALLOCATED
0	xx1x			UNALLOCATED
0	xxx1			UNALLOCATED
1	0000	1		UNALLOCATED
1	!= 0000			UNALLOCATED
	0000	0		SVE partition break condition

SVE propagate break to next partition

These instructions are under SVE Partition Break.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	0	S	0	1	1	0	0	0	0	1	Pg				0	Pn				0	Pdm			

Decode fields S	Instruction Details
0	BRKN, BRKNS — not setting the condition flags
1	BRKN, BRKNS — setting the condition flags

SVE partition break condition

These instructions are under SVE Partition Break.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	B	S	0	1	0	0	0	0	0	1	Pg				0	Pn				M	Pd			

Decode fields B	S	M	Instruction Details
	1	1	UNALLOCATED
0	0		BRKA, BRKAS — not setting the condition flags
0	1	0	BRKA, BRKAS — setting the condition flags
1	0		BRKB, BRKBS — not setting the condition flags
1	1	0	BRKB, BRKBS — setting the condition flags

SVE Predicate Misc

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00100101										01		op0				11		op1			op2		op3				op4				

Decode fields op0	op1	op2	op3	op4	Instruction details
0000		x0		0	SVE predicate test
0100		x0		0	UNALLOCATED
0x10		x0		0	UNALLOCATED
0xx1		x0		0	UNALLOCATED
0xxx		x1		0	UNALLOCATED
1000	000	00		0	SVE predicate first active

1000	000	!= 00		0	UNALLOCATED
1000	100	10	0000	0	SVE predicate zero
1000	100	10	!= 0000	0	UNALLOCATED
1000	110	00		0	SVE predicate read from FFR (predicated)
1001	000	0x		0	UNALLOCATED
1001	000	10		0	PNEXT
1001	000	11		0	UNALLOCATED
1001	100	10		0	UNALLOCATED
1001	110	00	0000	0	SVE predicate read from FFR (unpredicated)
1001	110	00	!= 0000	0	UNALLOCATED
100x	010			0	UNALLOCATED
100x	100	0x		0	SVE predicate initialize
100x	100	11		0	UNALLOCATED
100x	110	!= 00		0	UNALLOCATED
100x	xx1			0	UNALLOCATED
110x				0	UNALLOCATED
1x1x				0	UNALLOCATED
				1	UNALLOCATED

SVE predicate test

These instructions are under SVE Predicate Misc.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	op	S	0	1	0	0	0	0	1	1	Pg				0	Pn				0	opc2			

Decode fields op	S	opc2	Instruction Details
0	0		UNALLOCATED
0	1	0000	PTEST
0	1	0001	UNALLOCATED
0	1	001x	UNALLOCATED
0	1	01xx	UNALLOCATED
0	1	1xxx	UNALLOCATED
1			UNALLOCATED

SVE predicate first active

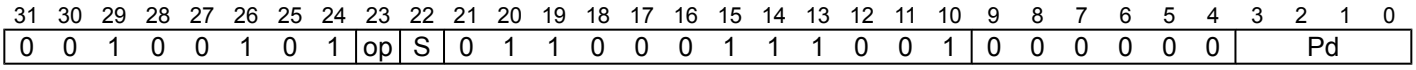
These instructions are under SVE Predicate Misc.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	op	S	0	1	1	0	0	0	1	1	0	0	0	0	0	Pg				0	Pdn			

Decode fields op	S	Instruction Details
0	0	UNALLOCATED
0	1	PFIRST
1		UNALLOCATED

SVE predicate zero

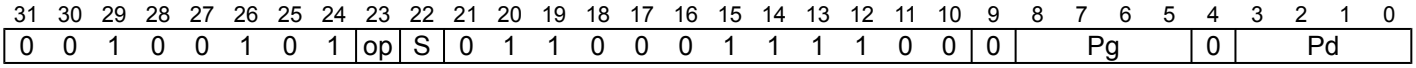
These instructions are under SVE Predicate Misc.



Decode fields op	S	Instruction Details
0	0	PFALSE
0	1	UNALLOCATED
1		UNALLOCATED

SVE predicate read from FFR (predicated)

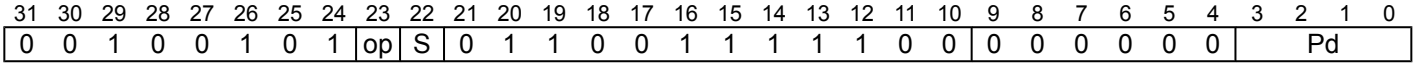
These instructions are under SVE Predicate Misc.



Decode fields op	S	Instruction Details
0	0	RDFFR, RDFFRS (predicated) — not setting the condition flags
0	1	RDFFR, RDFFRS (predicated) — setting the condition flags
1		UNALLOCATED

SVE predicate read from FFR (unpredicated)

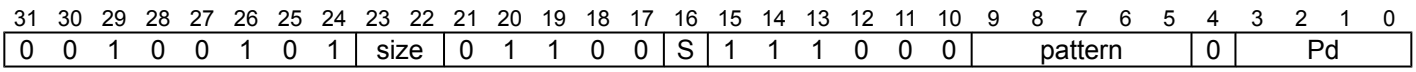
These instructions are under SVE Predicate Misc.



Decode fields op	S	Instruction Details
0	0	RDFFR (unpredicated)
0	1	UNALLOCATED
1		UNALLOCATED

SVE predicate initialize

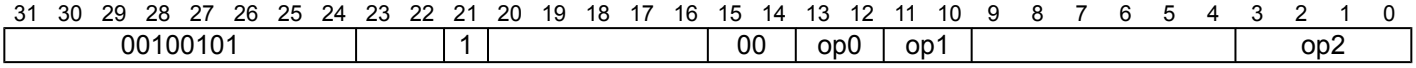
These instructions are under SVE Predicate Misc.



Decode fields S	Instruction Details
0	PTRUE, PTRUES — not setting the condition flags
1	PTRUE, PTRUES — setting the condition flags

SVE Integer Compare - Scalars

These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
0x			SVE integer compare scalar count and limit

10	00	0000	SVE conditionally terminate scalars
10	00	!= 0000	UNALLOCATED
11	00		SVE pointer conflict compare
1x	!= 00		UNALLOCATED

SVE integer compare scalar count and limit

These instructions are under SVE Integer Compare - Scalars.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		1	Rm					0	0	0	sf	U	lt	Rn					eq	Pd			

Decode fields U	lt	eq	Instruction Details
0	0	0	WHILEGE
0	0	1	WHILEGT
0	1	0	WHILELT
0	1	1	WHILELE
1	0	0	WHILEHS
1	0	1	WHILEHI
1	1	0	WHILELO
1	1	1	WHILELS

SVE conditionally terminate scalars

These instructions are under SVE Integer Compare - Scalars.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	op	sz	1	Rm					0	0	1	0	0	0	Rn					ne	0	0	0	0

Decode fields op	ne	Instruction Details
0		UNALLOCATED
1	0	CTERMEQ, CTERMNE — CTERMEQ
1	1	CTERMEQ, CTERMNE — CTERMNE

SVE pointer conflict compare

These instructions are under SVE Integer Compare - Scalars.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		1	Rm					0	0	1	1	0	0	Rn					rw	Pd			

Decode fields rw	Instruction Details
0	WHILEWR
1	WHILERW

SVE Integer Wide Immediate - Unpredicated

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00100101										1	op0				op1	11															

Decode fields op0	op1	Instruction details
00		SVE integer add/subtract immediate (unpredicated)
01		SVE integer min/max immediate (unpredicated)
10		SVE integer multiply immediate (unpredicated)
11	0	SVE broadcast integer immediate (unpredicated)
11	1	SVE broadcast floating-point immediate (unpredicated)

SVE integer add/subtract immediate (unpredicated)

These instructions are under SVE Integer Wide Immediate - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		1	0	0	opc			1	1	sh	imm8								Zdn				

Decode fields opc	Instruction Details
000	ADD (immediate)
001	SUB (immediate)
010	UNALLOCATED
011	SUBR (immediate)
100	SQADD (immediate)
101	UQADD (immediate)
110	SQSUB (immediate)
111	UQSUB (immediate)

SVE integer min/max immediate (unpredicated)

These instructions are under SVE Integer Wide Immediate - Unpredicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		1	0	1	opc			1	1	o2	imm8								Zdn				

Decode fields opc	o2	Instruction Details
0xx	1	UNALLOCATED
000	0	SMAX (immediate)
001	0	UMAX (immediate)
010	0	SMIN (immediate)
011	0	UMIN (immediate)
1xx		UNALLOCATED

SVE integer multiply immediate (unpredicated)

These instructions are under SVE Integer Wide Immediate - Unpredicated.

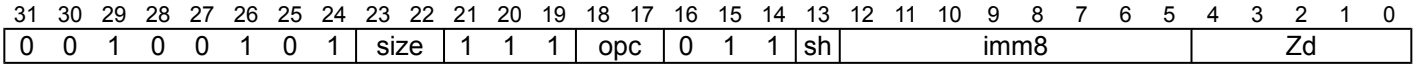
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	1	size		1	1	0	opc			1	1	o2	imm8								Zdn				

Decode fields opc	o2	Instruction Details
000	0	MUL (immediate)
000	1	UNALLOCATED
001		UNALLOCATED

Decode fields opc	o2	Instruction Details
01x		UNALLOCATED
1xx		UNALLOCATED

SVE broadcast integer immediate (unpredicated)

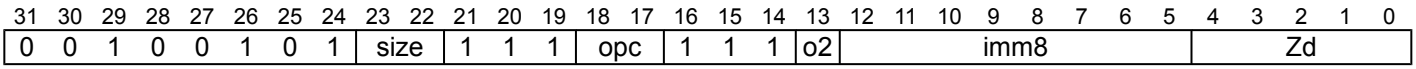
These instructions are under SVE Integer Wide Immediate - Unpredicated.



Decode fields opc	Instruction Details
00	DUP (immediate)
01	UNALLOCATED
1x	UNALLOCATED

SVE broadcast floating-point immediate (unpredicated)

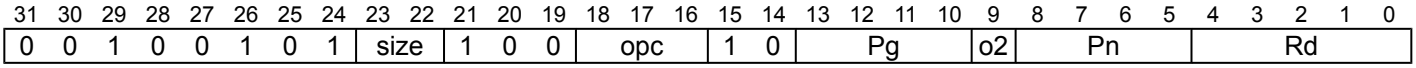
These instructions are under SVE Integer Wide Immediate - Unpredicated.



Decode fields opc	o2	Instruction Details
00	0	FDUP
00	1	UNALLOCATED
01		UNALLOCATED
1x		UNALLOCATED

SVE predicate count

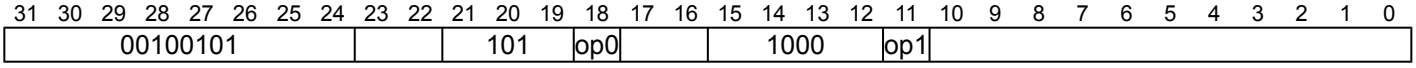
These instructions are under SVE encodings.



Decode fields opc	o2	Instruction Details
000	0	CNTP
000	1	UNALLOCATED
001		UNALLOCATED
01x		UNALLOCATED
1xx		UNALLOCATED

SVE Inc/Dec by Predicate Count

These instructions are under SVE encodings.

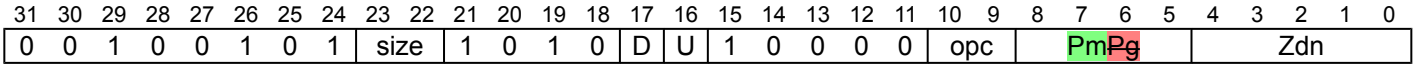


Decode fields	Instruction details

op0	op1	
0	0	SVE saturating inc/dec vector by predicate count
0	1	SVE saturating inc/dec register by predicate count
1	0	SVE inc/dec vector by predicate count
1	1	SVE inc/dec register by predicate count

SVE saturating inc/dec vector by predicate count

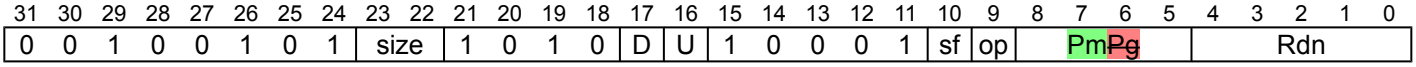
These instructions are under SVE Inc/Dec by Predicate Count.



Decode fields D	U	opc	Instruction Details
		01	UNALLOCATED
		1x	UNALLOCATED
0	0	00	SQINCP (vector)
0	1	00	UQINCP (vector)
1	0	00	SQDECP (vector)
1	1	00	UQDECP (vector)

SVE saturating inc/dec register by predicate count

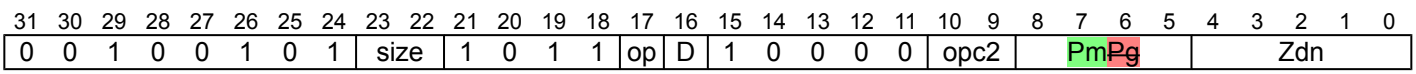
These instructions are under SVE Inc/Dec by Predicate Count.



Decode fields D	U	sf	op	Instruction Details
			1	UNALLOCATED
0	0	0	0	SQINCP (scalar) — 32-bit
0	0	1	0	SQINCP (scalar) — 64-bit
0	1	0	0	UQINCP (scalar) — 32-bit
0	1	1	0	UQINCP (scalar) — 64-bit
1	0	0	0	SQDECP (scalar) — 32-bit
1	0	1	0	SQDECP (scalar) — 64-bit
1	1	0	0	UQDECP (scalar) — 32-bit
1	1	1	0	UQDECP (scalar) — 64-bit

SVE inc/dec vector by predicate count

These instructions are under SVE Inc/Dec by Predicate Count.

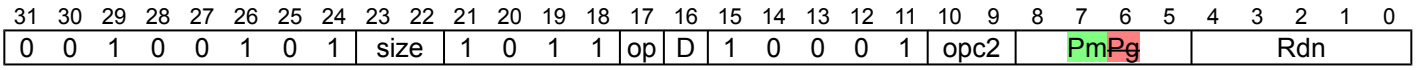


Decode fields op	D	opc2	Instruction Details
0		01	UNALLOCATED
0		1x	UNALLOCATED
0	0	00	INCP (vector)
0	1	00	DECP (vector)

Decode fields op	D	opc2	Instruction Details
1			UNALLOCATED

SVE inc/dec register by predicate count

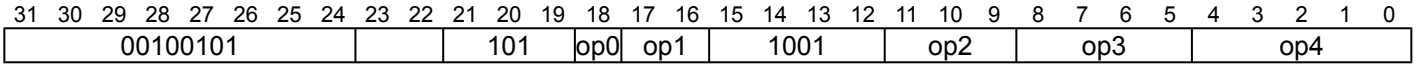
These instructions are under SVE Inc/Dec by Predicate Count.



Decode fields op	D	opc2	Instruction Details
0		01	UNALLOCATED
0		1x	UNALLOCATED
0	0	00	INCP (scalar)
0	1	00	DECP (scalar)
1			UNALLOCATED

SVE Write FFR

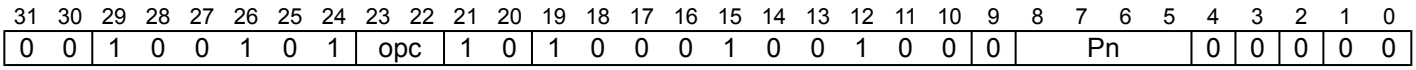
These instructions are under SVE encodings.



Decode fields op0	op1	op2	op3	op4	Instruction details
0	00	000		00000	SVE FFR write from predicate
1	00	000	0000	00000	SVE FFR initialise
1	00	000	1xxx	00000	UNALLOCATED
1	00	000	x1xx	00000	UNALLOCATED
1	00	000	xx1x	00000	UNALLOCATED
1	00	000	xxx1	00000	UNALLOCATED
	00	000		!= 00000	UNALLOCATED
	00	!= 000			UNALLOCATED
	!= 00				UNALLOCATED

SVE FFR write from predicate

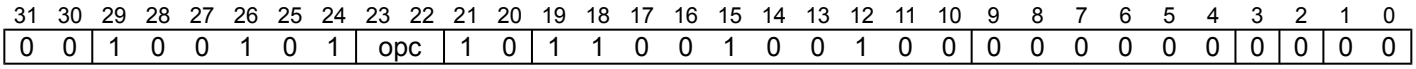
These instructions are under SVE Write FFR.



Decode fields opc	Instruction Details
00	WRFFR
01	UNALLOCATED
1x	UNALLOCATED

SVE FFR initialise

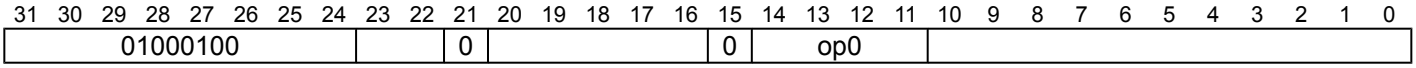
These instructions are under SVE Write FFR.



Decode fields opc	Instruction Details
00	SETFFR
01	UNALLOCATED
1x	UNALLOCATED

SVE Integer Multiply-Add - Unpredicated

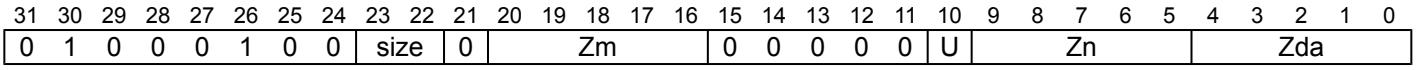
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0000	SVE integer dot product (unpredicated)
0001	SVE2 saturating multiply-add interleaved long
001x	CDOT (vectors)
01xx	SVE2 complex integer multiply-add
10xx	SVE2 integer multiply-add long
110x	SVE2 saturating multiply-add long
1110	SVE2 saturating multiply-add high
1111	UNALLOCATED

SVE integer dot product (unpredicated)

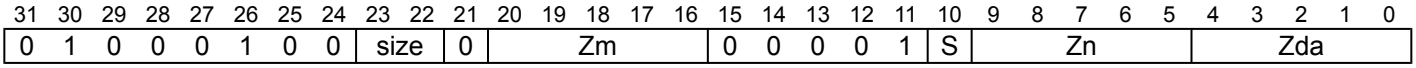
These instructions are under SVE Integer Multiply-Add - Unpredicated.



Decode fields U	Instruction Details
0	SDOT (vectors)
1	UDOT (vectors)

SVE2 saturating multiply-add interleaved long

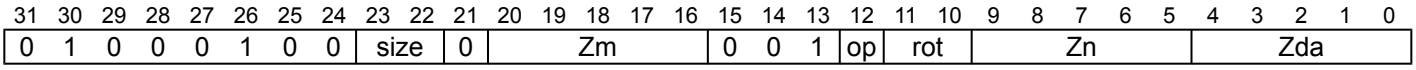
These instructions are under SVE Integer Multiply-Add - Unpredicated.



Decode fields S	Instruction Details
0	SQDMLALBT
1	SQDMLSLBT

SVE2 complex integer multiply-add

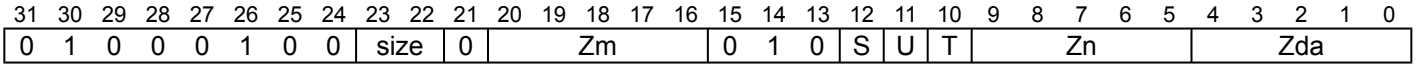
These instructions are under SVE Integer Multiply-Add - Unpredicated.



Decode fields op	Instruction Details
0	CMLA (vectors)
1	SQRDCMLAH (vectors)

SVE2 integer multiply-add long

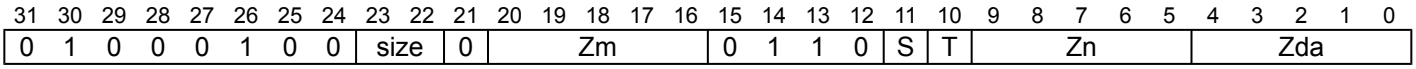
These instructions are under SVE Integer Multiply-Add - Unpredicated.



Decode fields S	U	T	Instruction Details
0	0	0	SMLALB (vectors)
0	0	1	SMLALT (vectors)
0	1	0	UMLALB (vectors)
0	1	1	UMLALT (vectors)
1	0	0	SMLSLB (vectors)
1	0	1	SMLSLT (vectors)
1	1	0	UMLSLB (vectors)
1	1	1	UMLSLT (vectors)

SVE2 saturating multiply-add long

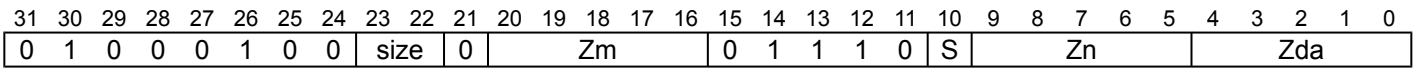
These instructions are under SVE Integer Multiply-Add - Unpredicated.



Decode fields S	T	Instruction Details
0	0	SQDMLALB (vectors)
0	1	SQDMLALT (vectors)
1	0	SQDMLSLB (vectors)
1	1	SQDMLSLT (vectors)

SVE2 saturating multiply-add high

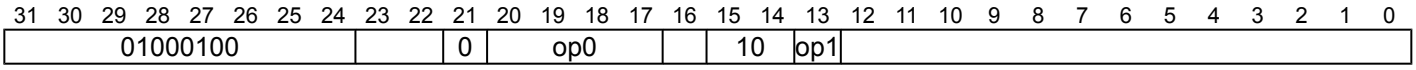
These instructions are under SVE Integer Multiply-Add - Unpredicated.



Decode fields S	Instruction Details
0	SQRDMLAH (vectors)
1	SQRDMLSH (vectors)

SVE2 Integer - Predicated

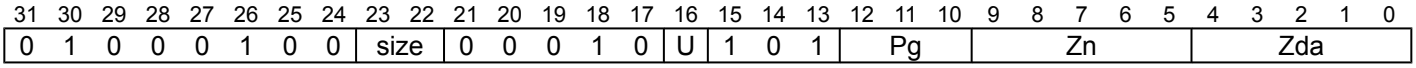
These instructions are under SVE encodings.



Decode fields op0	op1	Instruction details
0010	1	SVE2 integer pairwise add and accumulate long
0011	1	UNALLOCATED
011x	1	UNALLOCATED
0x0x	1	SVE2 integer unary operations (predicated)
0xxx	0	SVE2 saturating/rounding bitwise shift left (predicated)
10xx	0	SVE2 integer halving add/subtract (predicated)
10xx	1	SVE2 integer pairwise arithmetic
11xx	0	SVE2 saturating add/subtract
11xx	1	UNALLOCATED

SVE2 integer pairwise add and accumulate long

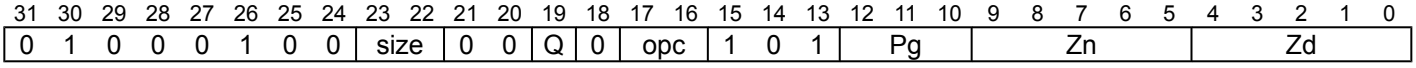
These instructions are under SVE2 Integer - Predicated.



Decode fields U	Instruction Details
0	SADALP
1	UADALP

SVE2 integer unary operations (predicated)

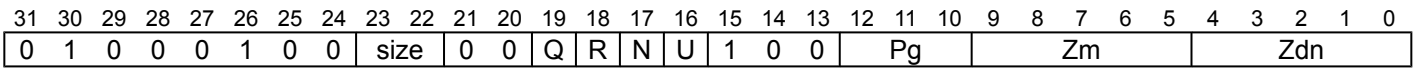
These instructions are under SVE2 Integer - Predicated.



Decode fields Q	opc	Instruction Details
	1x	UNALLOCATED
0	00	URECPE
0	01	URSQRTE
1	00	SQABS
1	01	SQNEG

SVE2 saturating/rounding bitwise shift left (predicated)

These instructions are under SVE2 Integer - Predicated.

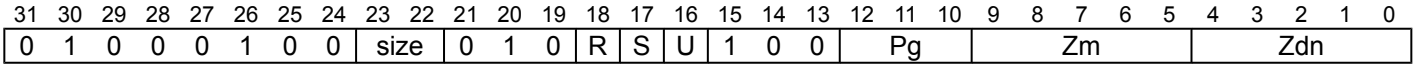


Decode fields Q	R	N	U	Instruction Details
0		0		UNALLOCATED
0	0	1	0	SRSHL
0	0	1	1	URSHL
0	1	1	0	SRSHLR

Decode fields Q	R	N	U	Instruction Details
0	1	1	1	URSHLR
1	0	0	0	SQSHL (vectors)
1	0	0	1	UQSHL (vectors)
1	0	1	0	SQRSHL
1	0	1	1	UQRSHL
1	1	0	0	SQSHLR
1	1	0	1	UQSHLR
1	1	1	0	SQRSHLR
1	1	1	1	UQRSHLR

SVE2 integer halving add/subtract (predicated)

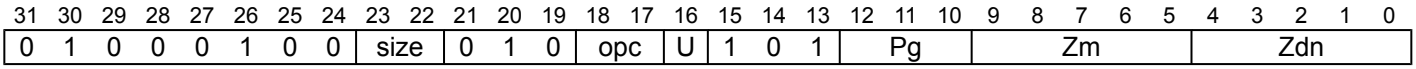
These instructions are under SVE2 Integer - Predicated.



Decode fields R	S	U	Instruction Details
0	0	0	SHADD
0	0	1	UHADD
0	1	0	SHSUB
0	1	1	UHSUB
1	0	0	SRHADD
1	0	1	URHADD
1	1	0	SHSUBR
1	1	1	UHSUBR

SVE2 integer pairwise arithmetic

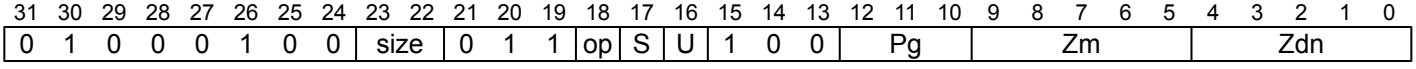
These instructions are under SVE2 Integer - Predicated.



Decode fields opc	U	Instruction Details
00	0	UNALLOCATED
00	1	ADDP
01		UNALLOCATED
10	0	SMAXP
10	1	UMAXP
11	0	SMINP
11	1	UMINP

SVE2 saturating add/subtract

These instructions are under SVE2 Integer - Predicated.



Decode fields op	S	U	Instruction Details
0	0	0	SQADD (vectors, predicated)
0	0	1	UQADD (vectors, predicated)
0	1	0	SQSUB (vectors, predicated)
0	1	1	UQSUB (vectors, predicated)
1	0	0	SUQADD
1	0	1	USQADD
1	1	0	SQSUBR
1	1	1	UQSUBR

SVE Multiply - Indexed

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
01000100										1						op0															

Decode fields op0	Instruction details
00000x	SVE integer dot product (indexed)
00001x	SVE2 integer multiply-add (indexed)
00010x	SVE2 saturating multiply-add high (indexed)
00011x	UNALLOCATED
001xxx	SVE2 saturating multiply-add (indexed)
0100xx	SVE2 complex integer dot product (indexed)
0101xx	UNALLOCATED
0110xx	SVE2 complex integer multiply-add (indexed)
0111xx	SVE2 complex saturating multiply-add (indexed)
10xxxx	SVE2 integer multiply-add long (indexed)
110xxx	SVE2 integer multiply long (indexed)
1110xx	SVE2 saturating multiply (indexed)
11110x	SVE2 saturating multiply high (indexed)
111110	SVE2 integer multiply (indexed)
111111	UNALLOCATED

SVE integer dot product (indexed)

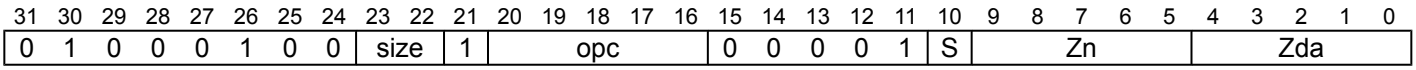
These instructions are under SVE Multiply - Indexed.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	1	0	0	size		1	opc					0	0	0	0	0	U	Zn					Zda				

Decode fields size	U	Instruction Details
0x		UNALLOCATED
10	0	SDOT (indexed) — 32-bit
10	1	UDOT (indexed) — 32-bit
11	0	SDOT (indexed) — 64-bit
11	1	UDOT (indexed) — 64-bit

SVE2 integer multiply-add (indexed)

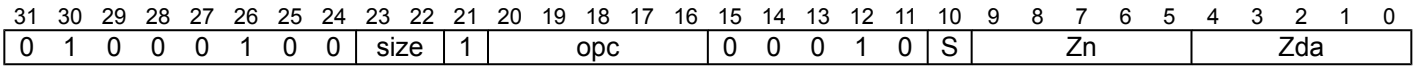
These instructions are under SVE Multiply - Indexed.



Decode fields size	S	Instruction Details
0x	0	MLA (indexed) — 16-bit
0x	1	MLS (indexed) — 16-bit
10	0	MLA (indexed) — 32-bit
10	1	MLS (indexed) — 32-bit
11	0	MLA (indexed) — 64-bit
11	1	MLS (indexed) — 64-bit

SVE2 saturating multiply-add high (indexed)

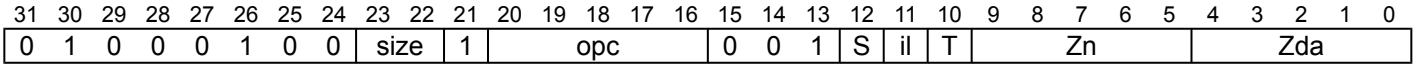
These instructions are under SVE Multiply - Indexed.



Decode fields size	S	Instruction Details
0x	0	SQRDMLAH (indexed) — 16-bit
0x	1	SQRDMLSH (indexed) — 16-bit
10	0	SQRDMLAH (indexed) — 32-bit
10	1	SQRDMLSH (indexed) — 32-bit
11	0	SQRDMLAH (indexed) — 64-bit
11	1	SQRDMLSH (indexed) — 64-bit

SVE2 saturating multiply-add (indexed)

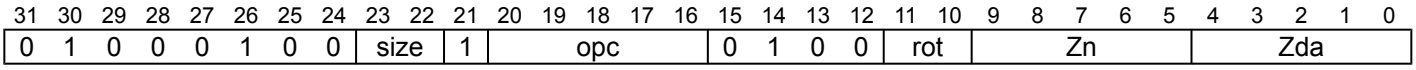
These instructions are under SVE Multiply - Indexed.



Decode fields size	S	T	Instruction Details
0x			UNALLOCATED
10	0	0	SQDMLALB (indexed) — 32-bit
10	0	1	SQDMLALT (indexed) — 32-bit
10	1	0	SQDMLSLB (indexed) — 32-bit
10	1	1	SQDMLSLT (indexed) — 32-bit
11	0	0	SQDMLALB (indexed) — 64-bit
11	0	1	SQDMLALT (indexed) — 64-bit
11	1	0	SQDMLSLB (indexed) — 64-bit
11	1	1	SQDMLSLT (indexed) — 64-bit

SVE2 complex integer dot product (indexed)

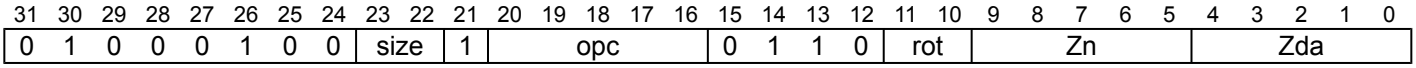
These instructions are under SVE Multiply - Indexed.



Decode fields size	Instruction Details
0x	UNALLOCATED
10	CDOT (indexed) — 32-bit
11	CDOT (indexed) — 64-bit

SVE2 complex integer multiply-add (indexed)

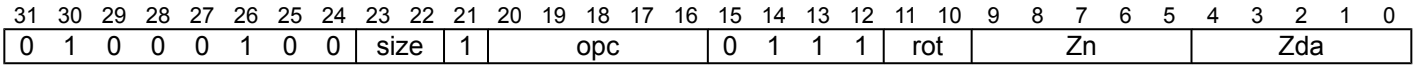
These instructions are under SVE Multiply - Indexed.



Decode fields size	Instruction Details
0x	UNALLOCATED
10	CMLA (indexed) — 16-bit
11	CMLA (indexed) — 32-bit

SVE2 complex saturating multiply-add (indexed)

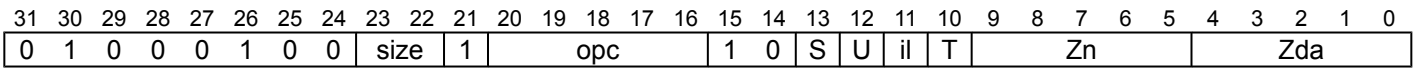
These instructions are under SVE Multiply - Indexed.



Decode fields size	Instruction Details
0x	UNALLOCATED
10	SQRDCMLAH (indexed) — 16-bit
11	SQRDCMLAH (indexed) — 32-bit

SVE2 integer multiply-add long (indexed)

These instructions are under SVE Multiply - Indexed.

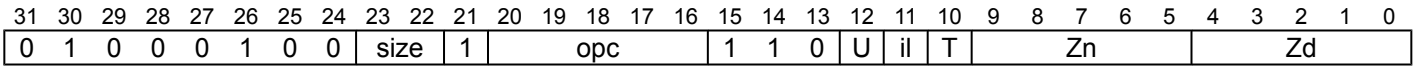


Decode fields size	S	U	T	Instruction Details
0x				UNALLOCATED
10	0	0	0	SMLALB (indexed) — 32-bit
10	0	0	1	SMLALT (indexed) — 32-bit
10	0	1	0	UMLALB (indexed) — 32-bit
10	0	1	1	UMLALT (indexed) — 32-bit
10	1	0	0	SMLSLB (indexed) — 32-bit
10	1	0	1	SMLSLT (indexed) — 32-bit
10	1	1	0	UMLSLB (indexed) — 32-bit
10	1	1	1	UMLSLT (indexed) — 32-bit
11	0	0	0	SMLALB (indexed) — 64-bit
11	0	0	1	SMLALT (indexed) — 64-bit

Decode fields size	S	U	T	Instruction Details
11	0	1	0	UMLALB (indexed) — 64-bit
11	0	1	1	UMLALT (indexed) — 64-bit
11	1	0	0	SMLSLB (indexed) — 64-bit
11	1	0	1	SMLSLT (indexed) — 64-bit
11	1	1	0	UMLSLB (indexed) — 64-bit
11	1	1	1	UMLSLT (indexed) — 64-bit

SVE2 integer multiply long (indexed)

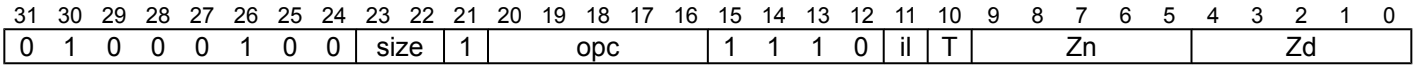
These instructions are under SVE Multiply - Indexed.



Decode fields size	U	T	Instruction Details
0x			UNALLOCATED
10	0	0	SMULLB (indexed) — 32-bit
10	0	1	SMULLT (indexed) — 32-bit
10	1	0	UMULLB (indexed) — 32-bit
10	1	1	UMULLT (indexed) — 32-bit
11	0	0	SMULLB (indexed) — 64-bit
11	0	1	SMULLT (indexed) — 64-bit
11	1	0	UMULLB (indexed) — 64-bit
11	1	1	UMULLT (indexed) — 64-bit

SVE2 saturating multiply (indexed)

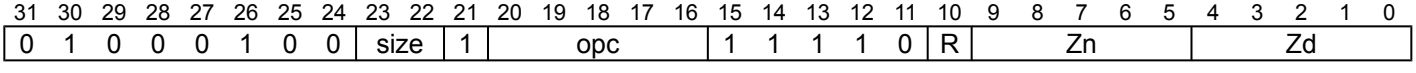
These instructions are under SVE Multiply - Indexed.



Decode fields size	T	Instruction Details
0x		UNALLOCATED
10	0	SQDMULLB (indexed) — 32-bit
10	1	SQDMULLT (indexed) — 32-bit
11	0	SQDMULLB (indexed) — 64-bit
11	1	SQDMULLT (indexed) — 64-bit

SVE2 saturating multiply high (indexed)

These instructions are under SVE Multiply - Indexed.

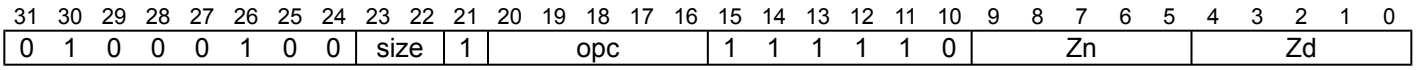


Decode fields size	R	Instruction Details
0x	0	SQDMULH (indexed) — 16-bit
0x	1	SQRDMULH (indexed) — 16-bit

Decode fields size	R	Instruction Details
10	0	SQDMULH (indexed) — 32-bit
10	1	SQRDMULH (indexed) — 32-bit
11	0	SQDMULH (indexed) — 64-bit
11	1	SQRDMULH (indexed) — 64-bit

SVE2 integer multiply (indexed)

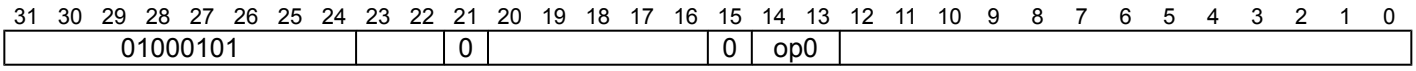
These instructions are under SVE Multiply - Indexed.



Decode fields size	Instruction Details
0x	MUL (indexed) — 16-bit
10	MUL (indexed) — 32-bit
11	MUL (indexed) — 64-bit

SVE2 Widening Integer Arithmetic

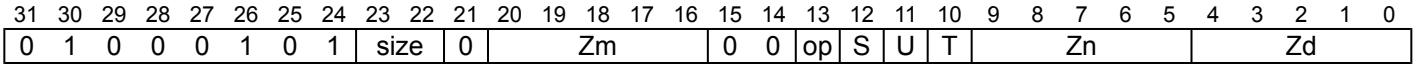
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0x	SVE2 integer add/subtract long
10	SVE2 integer add/subtract wide
11	SVE2 integer multiply long

SVE2 integer add/subtract long

These instructions are under SVE2 Widening Integer Arithmetic.

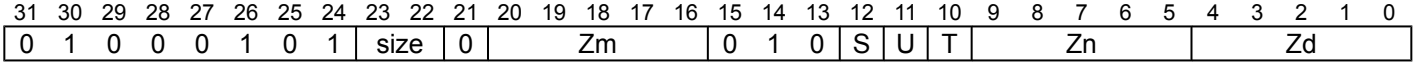


Decode fields op	S	U	T	Instruction Details
0	0	0	0	SADDLB
0	0	0	1	SADDLT
0	0	1	0	UADDLB
0	0	1	1	UADDLT
0	1	0	0	SSUBLB
0	1	0	1	SSUBLT
0	1	1	0	USUBLB
0	1	1	1	USUBLT
1	0			UNALLOCATED
1	1	0	0	SABDLB
1	1	0	1	SABDLT
1	1	1	0	UABDLB

Decode fields				Instruction Details
op	S	U	T	
1	1	1	1	UABDLT

SVE2 integer add/subtract wide

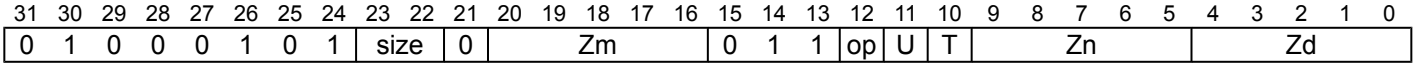
These instructions are under SVE2 Widening Integer Arithmetic.



Decode fields			Instruction Details
S	U	T	
0	0	0	SADDWB
0	0	1	SADDWT
0	1	0	UADDWB
0	1	1	UADDWT
1	0	0	SSUBWB
1	0	1	SSUBWT
1	1	0	USUBWB
1	1	1	USUBWT

SVE2 integer multiply long

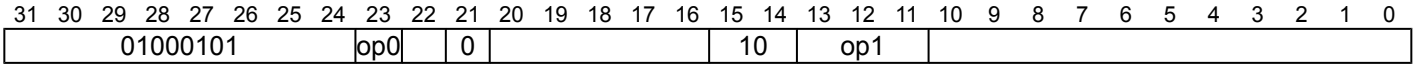
These instructions are under SVE2 Widening Integer Arithmetic.



Decode fields			Instruction Details
op	U	T	
0	0	0	SQDMULLB (vectors)
0	0	1	SQDMULLT (vectors)
0	1	0	PMULLB
0	1	1	PMULLT
1	0	0	SMULLB (vectors)
1	0	1	SMULLT (vectors)
1	1	0	UMULLB (vectors)
1	1	1	UMULLT (vectors)

SVE2 Misc

These instructions are under SVE encodings.

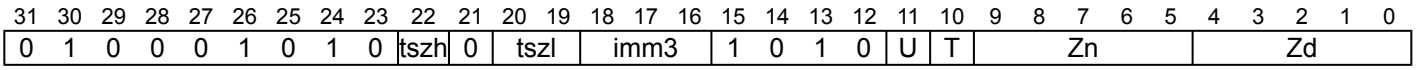


Decode fields		Instruction details
op0	op1	
0	10x	SVE2 bitwise shift left long
1	10x	UNALLOCATED
	00x	SVE2 integer add/subtract interleaved long
	010	SVE2 bitwise exclusive-or interleaved
	011	UNALLOCATED

	11x	SVE2 bitwise permute

SVE2 bitwise shift left long

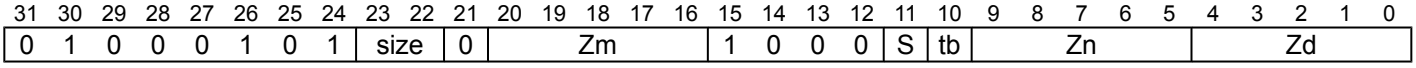
These instructions are under SVE2 Misc.



Decode fields U	T	Instruction Details
0	0	SSHLLB
0	1	SSHLLT
1	0	USHLLB
1	1	USHLLT

SVE2 integer add/subtract interleaved long

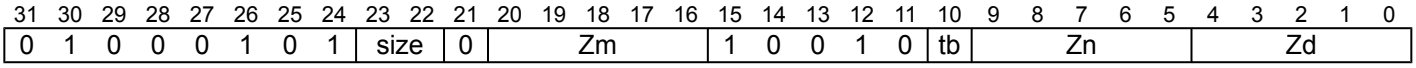
These instructions are under SVE2 Misc.



Decode fields S	tb	Instruction Details
0	0	SADDLBT
0	1	UNALLOCATED
1	0	SSUBLBT
1	1	SSUBLTB

SVE2 bitwise exclusive-or interleaved

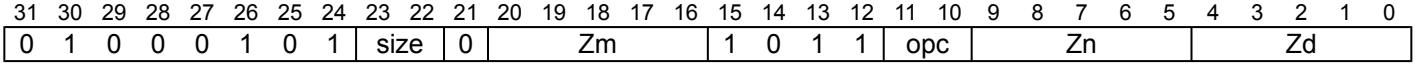
These instructions are under SVE2 Misc.



Decode fields tb	Instruction Details
0	EORBT
1	EORTB

SVE2 bitwise permute

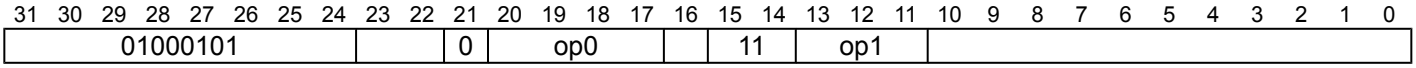
These instructions are under SVE2 Misc.



Decode fields opc	Instruction Details
00	BEXT
01	BDEP
10	BGRP
11	UNALLOCATED

SVE2 Accumulate

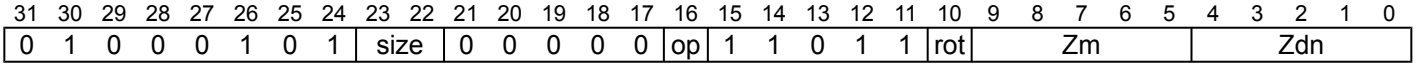
These instructions are under SVE encodings.



Decode fields op0	op1	Instruction details
0000	011	SVE2 complex integer add
!= 0000	011	UNALLOCATED
	00x	SVE2 integer absolute difference and accumulate long
	010	SVE2 integer add/subtract long with carry
	10x	SVE2 bitwise shift right and accumulate
	110	SVE2 bitwise shift and insert
	111	SVE2 integer absolute difference and accumulate

SVE2 complex integer add

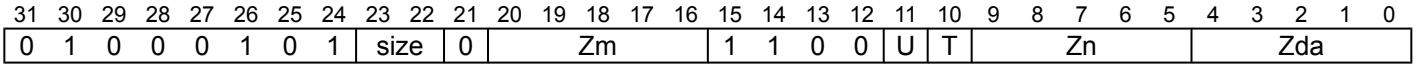
These instructions are under SVE2 Accumulate.



Decode fields op	Instruction Details
0	CADD
1	SQCADD

SVE2 integer absolute difference and accumulate long

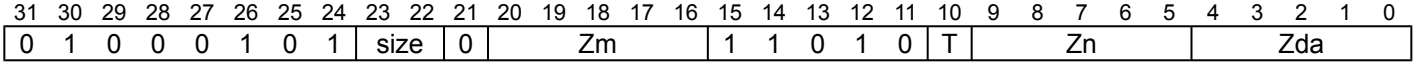
These instructions are under SVE2 Accumulate.



Decode fields U	T	Instruction Details
0	0	SABALB
0	1	SABALT
1	0	UABALB
1	1	UABALT

SVE2 integer add/subtract long with carry

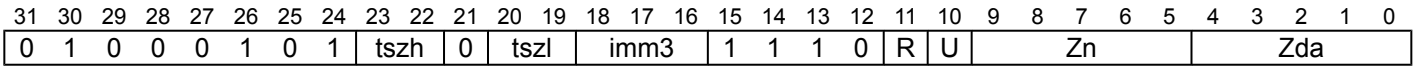
These instructions are under SVE2 Accumulate.



Decode fields size	T	Instruction Details
0x	0	ADCLB
0x	1	ADCLT
1x	0	SBCLB
1x	1	SBCLT

SVE2 bitwise shift right and accumulate

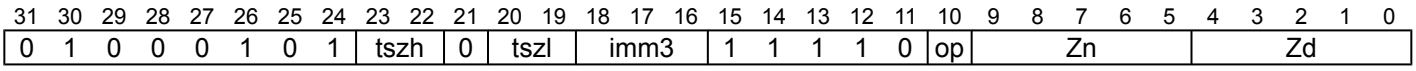
These instructions are under SVE2 Accumulate.



Decode fields R	U	Instruction Details
0	0	SSRA
0	1	USRA
1	0	SRSRA
1	1	URSRA

SVE2 bitwise shift and insert

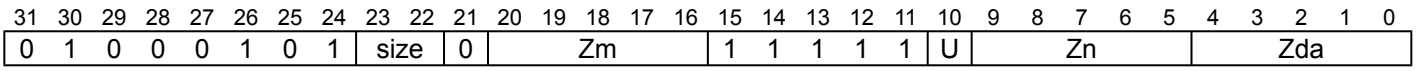
These instructions are under SVE2 Accumulate.



Decode fields op	Instruction Details
0	SRI
1	SLI

SVE2 integer absolute difference and accumulate

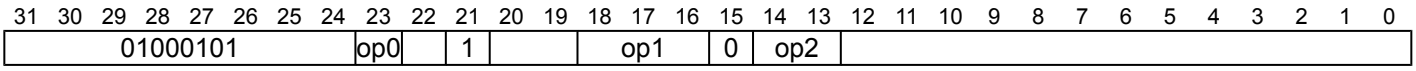
These instructions are under SVE2 Accumulate.



Decode fields U	Instruction Details
0	SABA
1	UABA

SVE2 Narrowing

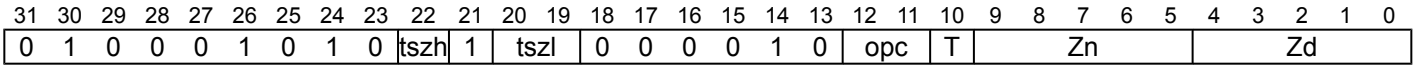
These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
0	000	10	SVE2 saturating extract narrow
0	!= 000	10	UNALLOCATED
0		0x	SVE2 bitwise shift right narrow
1		0x	UNALLOCATED
1		10	UNALLOCATED
		11	SVE2 integer add/subtract narrow high part

SVE2 saturating extract narrow

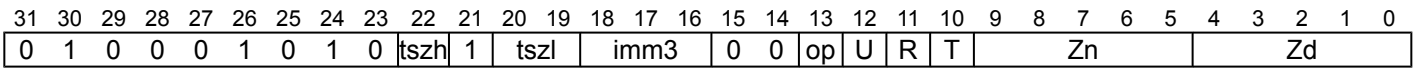
These instructions are under SVE2 Narrowing.



Decode fields opc	T	Instruction Details
00	0	SQXTNB
00	1	SQXTNT
01	0	UQXTNB
01	1	UQXTNT
10	0	SQXTUNB
10	1	SQXTUNT
11		UNALLOCATED

SVE2 bitwise shift right narrow

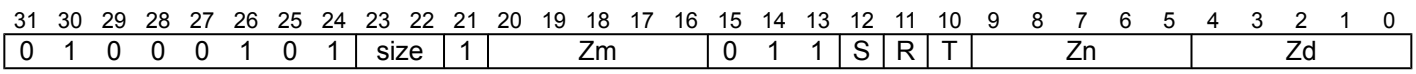
These instructions are under SVE2 Narrowing.



Decode fields op	U	R	T	Instruction Details
0	0	0	0	SQSHRUNB
0	0	0	1	SQSHRUNT
0	0	1	0	SQRSHRUNB
0	0	1	1	SQRSHRUNT
0	1	0	0	SHRNB
0	1	0	1	SHRNT
0	1	1	0	RSHRNB
0	1	1	1	RSHRNT
1	0	0	0	SQSHRNB
1	0	0	1	SQSHRNT
1	0	1	0	SQRSHRNB
1	0	1	1	SQRSHRNT
1	1	0	0	UQSHRNB
1	1	0	1	UQSHRNT
1	1	1	0	UQRSHRNB
1	1	1	1	UQRSHRNT

SVE2 integer add/subtract narrow high part

These instructions are under SVE2 Narrowing.

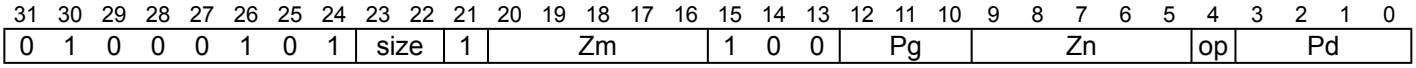


Decode fields S	R	T	Instruction Details
0	0	0	ADDHNB
0	0	1	ADDHNT
0	1	0	RADDHNB
0	1	1	RADDHNT
1	0	0	SUBHNB
1	0	1	SUBHNT

Decode fields S	R	T	Instruction Details
1	1	0	RSUBHNB
1	1	1	RSUBHNT

SVE2 character match

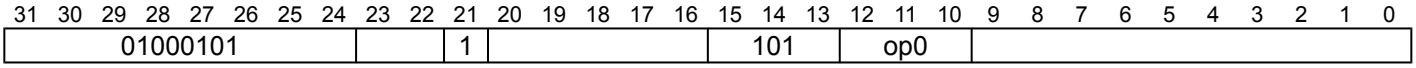
These instructions are under SVE encodings.



Decode fields op	Instruction Details
0	MATCH
1	NMATCH

SVE2 Histogram Computation - Segment

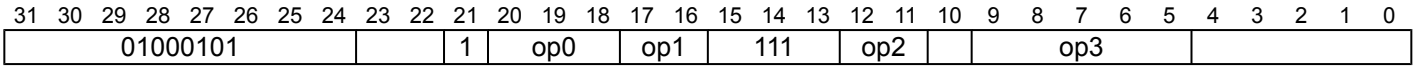
These instructions are under SVE encodings.



Decode fields op0	Instruction details
000	HISTSEG
!= 000	UNALLOCATED

SVE2 Crypto Extensions

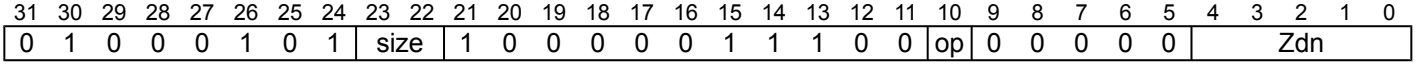
These instructions are under SVE encodings.



Decode fields op0	op1	op2	op3	Instruction details
000	00	00	00000	SVE2 crypto unary operations
000	00	00	!= 00000	UNALLOCATED
000	00	x1		UNALLOCATED
000	01	0x		UNALLOCATED
000	01	11		UNALLOCATED
000	1x	00		SVE2 crypto destructive binary operations
000	1x	x1		UNALLOCATED
!= 000		0x		UNALLOCATED
!= 000		11		UNALLOCATED
		10		SVE2 crypto constructive binary operations

SVE2 crypto unary operations

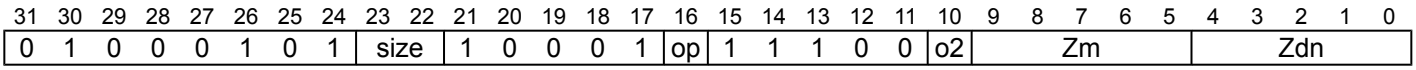
These instructions are under SVE2 Crypto Extensions.



Decode fields size	op	Instruction Details
00	0	AESMC
00	1	AESIMC
01		UNALLOCATED
1x		UNALLOCATED

SVE2 crypto destructive binary operations

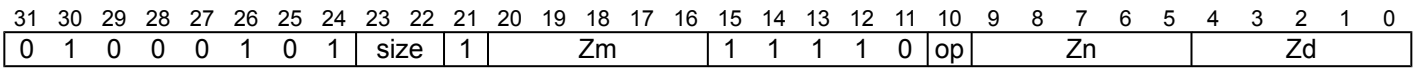
These instructions are under SVE2 Crypto Extensions.



Decode fields size	op	o2	Instruction Details
00	0	0	AESE
00	0	1	AESD
00	1	0	SM4E
00	1	1	UNALLOCATED
01			UNALLOCATED
1x			UNALLOCATED

SVE2 crypto constructive binary operations

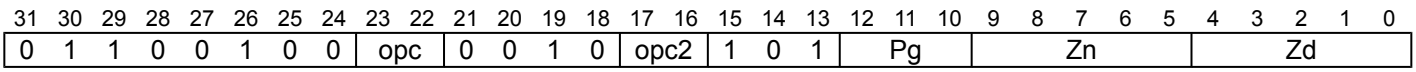
These instructions are under SVE2 Crypto Extensions.



Decode fields size	op	Instruction Details
00	0	SM4EKEY
00	1	RAX1
01		UNALLOCATED
1x		UNALLOCATED

SVE2 floating-point convert precision

These instructions are under SVE encodings.

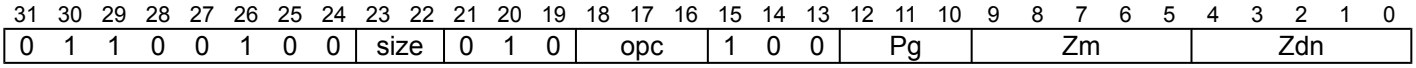


Decode fields opc	opc2	Instruction Details
00	0x	UNALLOCATED
00	10	FCVTXNT
00	11	UNALLOCATED
01		UNALLOCATED
10	00	FCVTNT — single-precision to half-precision
10	01	FCVTLT — half-precision to single-precision
10	1x	UNALLOCATED
11	0x	UNALLOCATED

Decode fields opc	opc2	Instruction Details
11	10	FCVTNT — double-precision to single-precision
11	11	FCVTLT — single-precision to double-precision

SVE2 floating-point pairwise operations

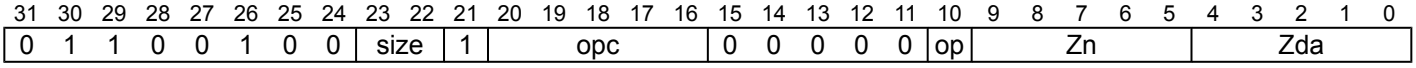
These instructions are under SVE encodings.



Decode fields opc	Instruction Details
000	FADDP
001	UNALLOCATED
01x	UNALLOCATED
100	FMAXNMP
101	FMINNMP
110	FMAXP
111	FMINP

SVE floating-point multiply-add (indexed)

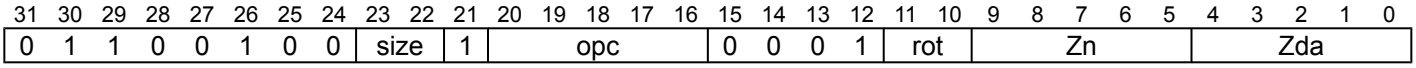
These instructions are under SVE encodings.



Decode fields size	op	Instruction Details
0x	0	FMLA (indexed) — half-precision
0x	1	FMLS (indexed) — half-precision
10	0	FMLA (indexed) — single-precision
10	1	FMLS (indexed) — single-precision
11	0	FMLA (indexed) — double-precision
11	1	FMLS (indexed) — double-precision

SVE floating-point complex multiply-add (indexed)

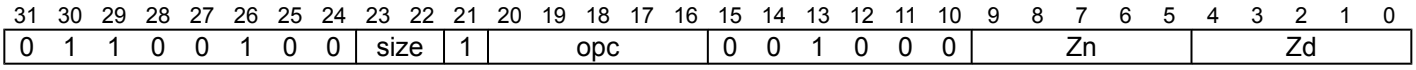
These instructions are under SVE encodings.



Decode fields size	Instruction Details
0x	UNALLOCATED
10	FCMLA (indexed) — half-precision
11	FCMLA (indexed) — single-precision

SVE floating-point multiply (indexed)

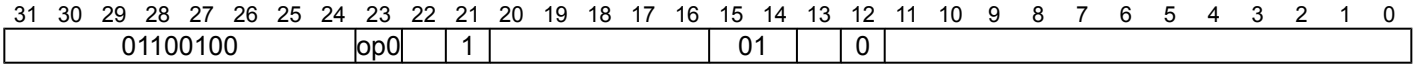
These instructions are under SVE encodings.



Decode fields size	Instruction Details
0x	FMUL (indexed) — half-precision
10	FMUL (indexed) — single-precision
11	FMUL (indexed) — double-precision

SVE2 Floating Point Widening Multiply-Add - Indexed

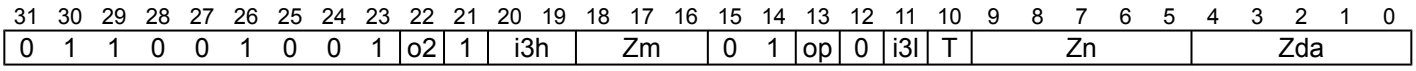
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	UNALLOCATED
1	SVE2 floating-point multiply-add long (indexed)

SVE2 floating-point multiply-add long (indexed)

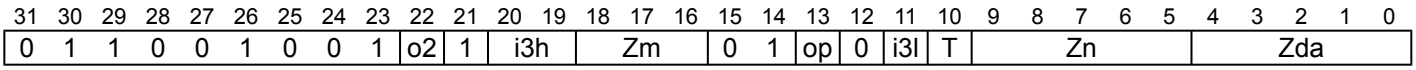
These instructions are under SVE encodings.



Decode fields o2	op	T	Instruction Details
0	0	0	FMLALB (indexed)
0	0	1	FMLALT (indexed)
0	1	0	FMLSLB (indexed)
0	1	1	FMLSLT (indexed)
1			UNALLOCATED

SVE2 floating-point multiply-add long (indexed)

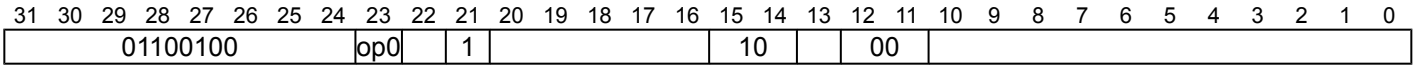
These instructions are under SVE2 Floating Point Widening Multiply-Add - Indexed.



Decode fields o2	op	T	Instruction Details
0	0	0	FMLALB (indexed)
0	0	1	FMLALT (indexed)
0	1	0	FMLSLB (indexed)
0	1	1	FMLSLT (indexed)
1			UNALLOCATED

SVE2 Floating Point Widening Multiply-Add

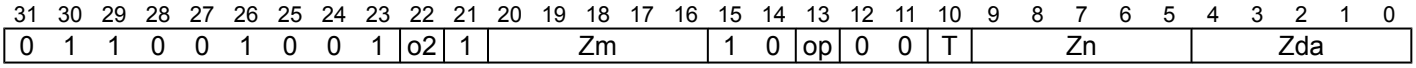
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	UNALLOCATED
1	SVE2 floating-point multiply-add long

SVE2 floating-point multiply-add long

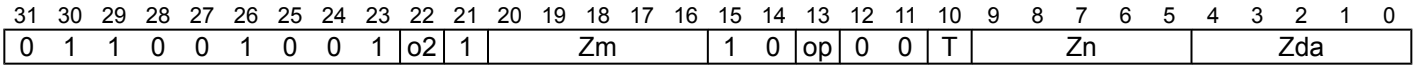
These instructions are under SVE encodings.



Decode fields o2	op	T	Instruction Details
0	0	0	FMLALB (vectors)
0	0	1	FMLALT (vectors)
0	1	0	FMLSLB (vectors)
0	1	1	FMLSLT (vectors)
1			UNALLOCATED

SVE2 floating-point multiply-add long

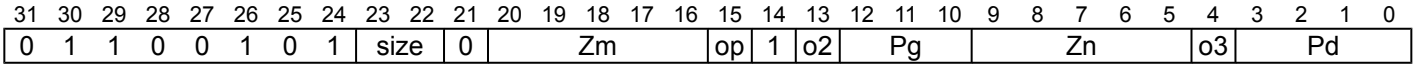
These instructions are under SVE2 Floating Point Widening Multiply-Add.



Decode fields o2	op	T	Instruction Details
0	0	0	FMLALB (vectors)
0	0	1	FMLALT (vectors)
0	1	0	FMLSLB (vectors)
0	1	1	FMLSLT (vectors)
1			UNALLOCATED

SVE floating-point compare vectors

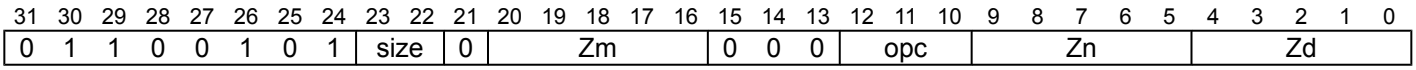
These instructions are under SVE encodings.



Decode fields op	o2	o3	Instruction Details
0	0	0	FCM<cc> (vectors) — FCMGE
0	0	1	FCM<cc> (vectors) — FCMGT
0	1	0	FCM<cc> (vectors) — FCMEQ
0	1	1	FCM<cc> (vectors) — FCMNE
1	0	0	FCM<cc> (vectors) — FCMUO
1	0	1	FAC<cc> — FACGE
1	1	0	UNALLOCATED
1	1	1	FAC<cc> — FACGT

SVE floating-point arithmetic (unpredicated)

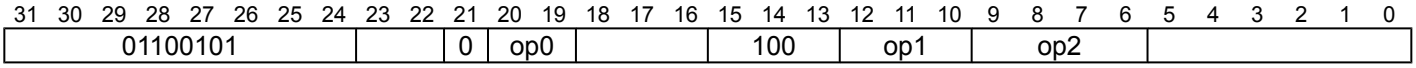
These instructions are under SVE encodings.



Decode fields opc	Instruction Details
000	FADD (vectors, unpredicated)
001	FSUB (vectors, unpredicated)
010	FMUL (vectors, unpredicated)
011	FTSMUL
10x	UNALLOCATED
110	FRECPS
111	FRSQRTS

SVE Floating Point Arithmetic - Predicated

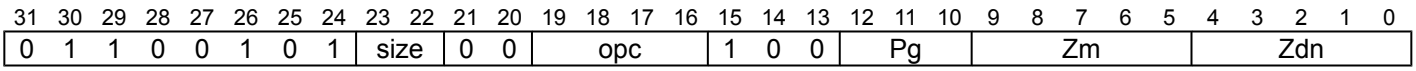
These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
0x			SVE floating-point arithmetic (predicated)
10	000		FTMAD
10	!= 000		UNALLOCATED
11		0000	SVE floating-point arithmetic with immediate (predicated)
11		!= 0000	UNALLOCATED

SVE floating-point arithmetic (predicated)

These instructions are under SVE Floating Point Arithmetic - Predicated.

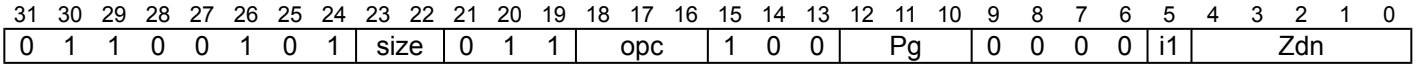


Decode fields opc	Instruction Details
0000	FADD (vectors, predicated)
0001	FSUB (vectors, predicated)
0010	FMUL (vectors, predicated)
0011	FSUBR (vectors)
0100	FMAXNM (vectors)
0101	FMINNM (vectors)
0110	FMAX (vectors)
0111	FMIN (vectors)
1000	FABD
1001	FSCALE
1010	FMULX
1011	UNALLOCATED
1100	FDIVR

Decode fields opc	Instruction Details
1101	FDIV
111x	UNALLOCATED

SVE floating-point arithmetic with immediate (predicated)

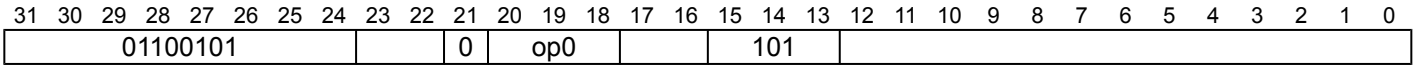
These instructions are under SVE Floating Point Arithmetic - Predicated.



Decode fields opc	Instruction Details
000	FADD (immediate)
001	FSUB (immediate)
010	FMUL (immediate)
011	FSUBR (immediate)
100	FMAXNM (immediate)
101	FMINNM (immediate)
110	FMAX (immediate)
111	FMIN (immediate)

SVE Floating Point Unary Operations - Predicated

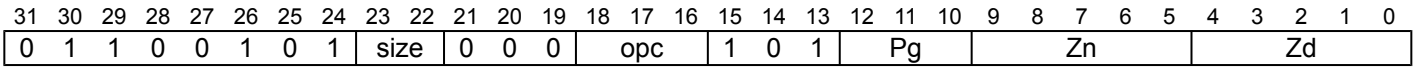
These instructions are under SVE encodings.



Decode fields op0	Instruction details
00x	SVE floating-point round to integral value
010	SVE floating-point convert precision
011	SVE floating-point unary operations
10x	SVE integer convert to floating-point
11x	SVE floating-point convert to integer

SVE floating-point round to integral value

These instructions are under SVE Floating Point Unary Operations - Predicated.

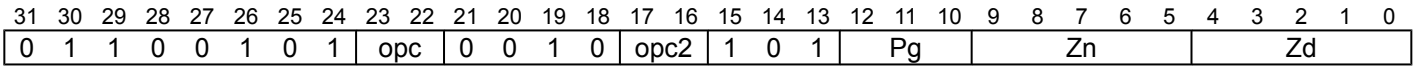


Decode fields opc	Instruction Details
000	FRINT<r> — nearest with ties to even
001	FRINT<r> — toward plus infinity
010	FRINT<r> — toward minus infinity
011	FRINT<r> — toward zero
100	FRINT<r> — nearest with ties to away
101	UNALLOCATED
110	FRINT<r> — current mode signalling inexact

Decode fields opc	Instruction Details
111	FRINT<r> — current mode

SVE floating-point convert precision

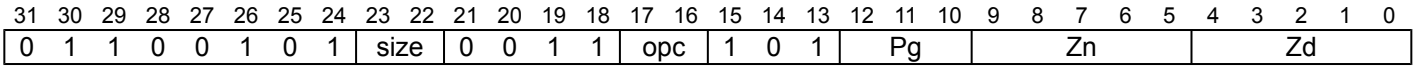
These instructions are under SVE Floating Point Unary Operations - Predicated.



Decode fields opc	opc2	Instruction Details
00	0x	UNALLOCATED
00	10	FCVTX
00	11	UNALLOCATED
01		UNALLOCATED
10	00	FCVT — single-precision to half-precision
10	01	FCVT — half-precision to single-precision
10	1x	UNALLOCATED
11	00	FCVT — double-precision to half-precision
11	01	FCVT — half-precision to double-precision
11	10	FCVT — double-precision to single-precision
11	11	FCVT — single-precision to double-precision

SVE floating-point unary operations

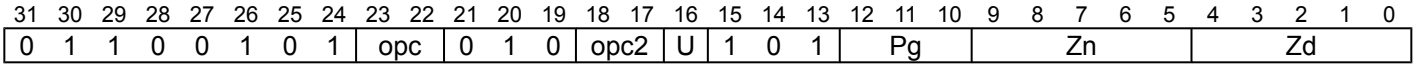
These instructions are under SVE Floating Point Unary Operations - Predicated.



Decode fields opc	Instruction Details
00	FRECPX
01	FSQRT
1x	UNALLOCATED

SVE integer convert to floating-point

These instructions are under SVE Floating Point Unary Operations - Predicated.



Decode fields opc	opc2	U	Instruction Details
00			UNALLOCATED
01	00		UNALLOCATED
01	01	0	SCVTF — 16-bit to half-precision
01	01	1	UCVTF — 16-bit to half-precision
01	10	0	SCVTF — 32-bit to half-precision
01	10	1	UCVTF — 32-bit to half-precision
01	11	0	SCVTF — 64-bit to half-precision

Decode fields opc	opc2	U	Instruction Details
01	11	1	UCVTF — 64-bit to half-precision
10	0x		UNALLOCATED
10	10	0	SCVTF — 32-bit to single-precision
10	10	1	UCVTF — 32-bit to single-precision
10	11		UNALLOCATED
11	00	0	SCVTF — 32-bit to double-precision
11	00	1	UCVTF — 32-bit to double-precision
11	01		UNALLOCATED
11	10	0	SCVTF — 64-bit to single-precision
11	10	1	UCVTF — 64-bit to single-precision
11	11	0	SCVTF — 64-bit to double-precision
11	11	1	UCVTF — 64-bit to double-precision

SVE floating-point convert to integer

These instructions are under SVE Floating Point Unary Operations - Predicated.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	0	0	1	0	1	opc		0	1	1	opc2		U	1	0	1	Pg			Zn					Zd				

Decode fields opc	opc2	U	Instruction Details
00		0	FLOGB
00		1	UNALLOCATED
01	00		UNALLOCATED
01	01	0	FCVTZS — half-precision to 16-bit
01	01	1	FCVTZU — half-precision to 16-bit
01	10	0	FCVTZS — half-precision to 32-bit
01	10	1	FCVTZU — half-precision to 32-bit
01	11	0	FCVTZS — half-precision to 64-bit
01	11	1	FCVTZU — half-precision to 64-bit
10	0x		UNALLOCATED
10	10	0	FCVTZS — single-precision to 32-bit
10	10	1	FCVTZU — single-precision to 32-bit
10	11		UNALLOCATED
11	00	0	FCVTZS — double-precision to 32-bit
11	00	1	FCVTZU — double-precision to 32-bit
11	01		UNALLOCATED
11	10	0	FCVTZS — single-precision to 64-bit
11	10	1	FCVTZU — single-precision to 64-bit
11	11	0	FCVTZS — double-precision to 64-bit
11	11	1	FCVTZU — double-precision to 64-bit

SVE floating-point recursive reduction

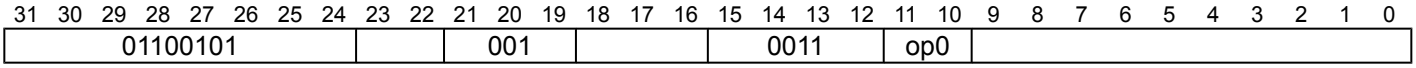
These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	0	0	1	0	1	size		0	0	0	opc			0	0	1	Pg			Zn					Vd				

Decode fields opc	Instruction Details
000	FADDV
001	UNALLOCATED
01x	UNALLOCATED
100	FMAXNMV
101	FMINNMV
110	FMAXV
111	FMINV

SVE Floating Point Unary Operations - Unpredicated

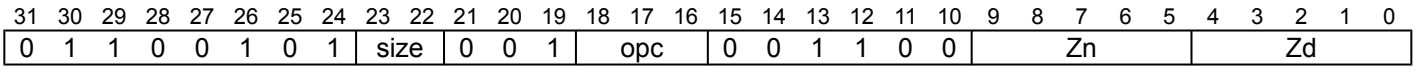
These instructions are under SVE encodings.



Decode fields op0	Instruction details
00	SVE floating-point reciprocal estimate (unpredicated)
!= 00	UNALLOCATED

SVE floating-point reciprocal estimate (unpredicated)

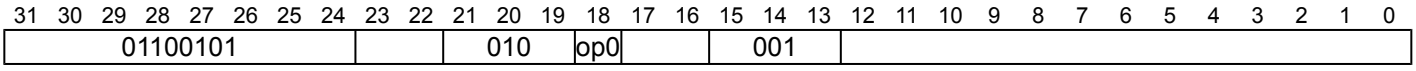
These instructions are under SVE Floating Point Unary Operations - Unpredicated.



Decode fields opc	Instruction Details
0xx	UNALLOCATED
10x	UNALLOCATED
110	FRECPE
111	FRSQRTE

SVE Floating Point Compare - with Zero

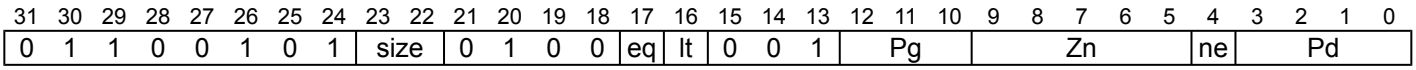
These instructions are under SVE encodings.



Decode fields op0	Instruction details
0	SVE floating-point compare with zero
1	UNALLOCATED

SVE floating-point compare with zero

These instructions are under SVE Floating Point Compare - with Zero.



Decode fields eq	lt	ne	Instruction Details
0	0	0	FCM<cc> (zero) — FCMGE
0	0	1	FCM<cc> (zero) — FCMGT
0	1	0	FCM<cc> (zero) — FCMLT
0	1	1	FCM<cc> (zero) — FCMLE
1		1	UNALLOCATED
1	0	0	FCM<cc> (zero) — FCMEQ
1	1	0	FCM<cc> (zero) — FCMNE

SVE floating-point serial reduction (predicated)

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	0	0	1	0	1	size		0	1	1	opc			0	0	1	Pg			Zm					Vdn				

Decode fields opc	Instruction Details
000	FADDA
001	UNALLOCATED
01x	UNALLOCATED
1xx	UNALLOCATED

SVE Floating Point Multiply-Add

These instructions are under SVE encodings.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
01100101										1						op0															

Decode fields op0	Instruction details
0	SVE floating-point multiply-accumulate writing addend
1	SVE floating-point multiply-accumulate writing multiplicand

SVE floating-point multiply-accumulate writing addend

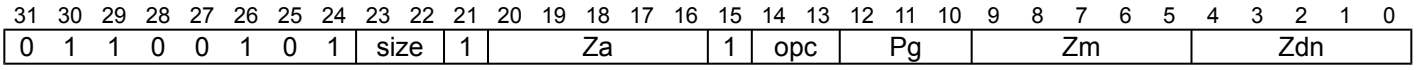
These instructions are under SVE Floating Point Multiply-Add.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	1	0	0	1	0	1	size		1	Zm					0	opc		Pg			Zn					Zda				

Decode fields opc	Instruction Details
00	FMLA (vectors)
01	FMLS (vectors)
10	FNMLA
11	FNMLS

SVE floating-point multiply-accumulate writing multiplicand

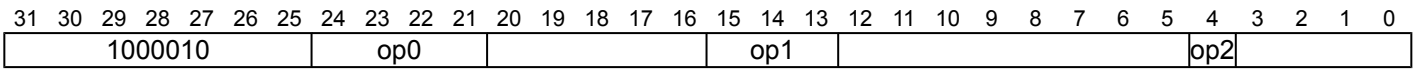
These instructions are under SVE Floating Point Multiply-Add.



Decode fields opc	Instruction Details
00	FMAD
01	FMSB
10	FNMAD
11	FNMSB

SVE Memory - 32-bit Gather and Unsized Contiguous

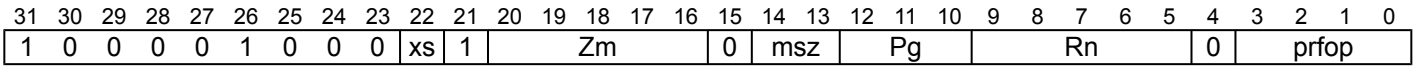
These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
00x1	0xx	0	SVE 32-bit gather prefetch (scalar plus 32-bit scaled offsets)
00x1	0xx	1	UNALLOCATED
01x1	0xx		SVE 32-bit gather load halfwords (scalar plus 32-bit scaled offsets)
10x1	0xx		SVE 32-bit gather load words (scalar plus 32-bit scaled offsets)
1101	000	1	UNALLOCATED
1101	0x1		UNALLOCATED
110x	000	0	LDR (predicate)
110x	010		LDR (vector)
1111	0xx	1	UNALLOCATED
111x	0xx	0	SVE contiguous prefetch (scalar plus immediate)
xx00	10x		SVE2 32-bit gather non-temporal load (scalar plus 32-bit unscaled offsets)
xx00	110	0	SVE contiguous prefetch (scalar plus scalar)
xx00	111	0	SVE 32-bit gather prefetch (vector plus immediate)
xx00	11x	1	UNALLOCATED
xx01	1xx		SVE 32-bit gather load (vector plus immediate)
xx1x	1xx		SVE load and broadcast element
xxx0	0xx		SVE 32-bit gather load (scalar plus 32-bit unscaled offsets)

SVE 32-bit gather prefetch (scalar plus 32-bit scaled offsets)

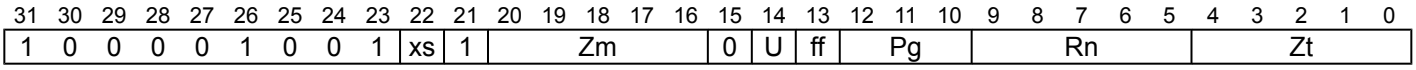
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields msz	Instruction Details
00	PRFB (scalar plus vector)
01	PRFH (scalar plus vector)
10	PRFW (scalar plus vector)
11	PRFD (scalar plus vector)

SVE 32-bit gather load halfwords (scalar plus 32-bit scaled offsets)

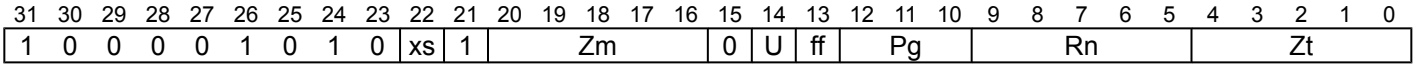
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields U	ff	Instruction Details
0	0	LD1SH (scalar plus vector)
0	1	LDFF1SH (scalar plus vector)
1	0	LD1H (scalar plus vector)
1	1	LDFF1H (scalar plus vector)

SVE 32-bit gather load words (scalar plus 32-bit scaled offsets)

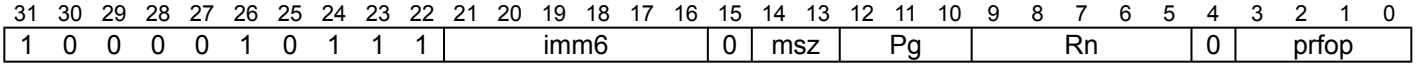
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields U	ff	Instruction Details
0		UNALLOCATED
1	0	LD1W (scalar plus vector)
1	1	LDFF1W (scalar plus vector)

SVE contiguous prefetch (scalar plus immediate)

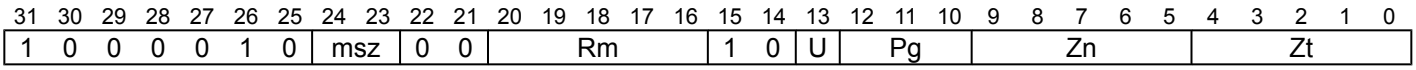
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields msz	Instruction Details
00	PRFB (scalar plus immediate)
01	PRFH (scalar plus immediate)
10	PRFW (scalar plus immediate)
11	PRFD (scalar plus immediate)

SVE2 32-bit gather non-temporal load (scalar plus 32-bit unscaled offsets)

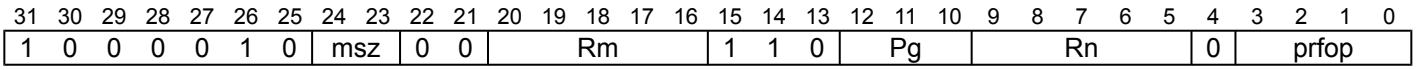
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields msz	U	Instruction Details
00	0	LDNT1SB
00	1	LDNT1B (vector plus scalar)
01	0	LDNT1SH
01	1	LDNT1H (vector plus scalar)
10	0	UNALLOCATED
10	1	LDNT1W (vector plus scalar)
11		UNALLOCATED

SVE contiguous prefetch (scalar plus scalar)

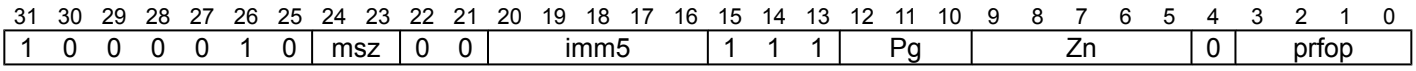
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields msz	Instruction Details
00	PRFB (scalar plus scalar)
01	PRFH (scalar plus scalar)
10	PRFW (scalar plus scalar)
11	PRFD (scalar plus scalar)

SVE 32-bit gather prefetch (vector plus immediate)

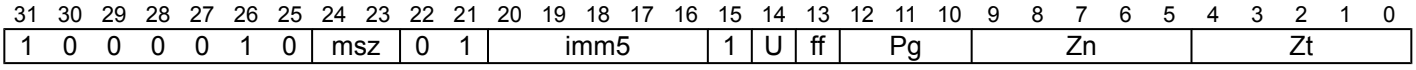
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields msz	Instruction Details
00	PRFB (vector plus immediate)
01	PRFH (vector plus immediate)
10	PRFW (vector plus immediate)
11	PRFD (vector plus immediate)

SVE 32-bit gather load (vector plus immediate)

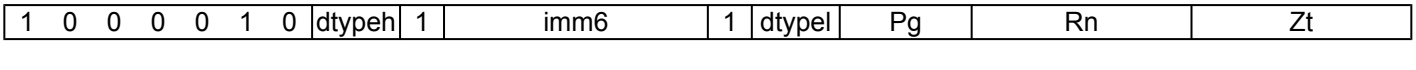
These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields msz	U	ff	Instruction Details
00	0	0	LD1SB (vector plus immediate)
00	0	1	LDFF1SB (vector plus immediate)
00	1	0	LD1B (vector plus immediate)
00	1	1	LDFF1B (vector plus immediate)
01	0	0	LD1SH (vector plus immediate)
01	0	1	LDFF1SH (vector plus immediate)
01	1	0	LD1H (vector plus immediate)
01	1	1	LDFF1H (vector plus immediate)
10	0		UNALLOCATED
10	1	0	LD1W (vector plus immediate)
10	1	1	LDFF1W (vector plus immediate)
11			UNALLOCATED

SVE load and broadcast element

These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.



Decode fields dtypeh	dtypel	Instruction Details
00	00	LD1RB — 8-bit element
00	01	LD1RB — 16-bit element
00	10	LD1RB — 32-bit element
00	11	LD1RB — 64-bit element
01	00	LD1RSW
01	01	LD1RH — 16-bit element
01	10	LD1RH — 32-bit element
01	11	LD1RH — 64-bit element
10	00	LD1RSH — 64-bit element
10	01	LD1RSH — 32-bit element
10	10	LD1RW — 32-bit element
10	11	LD1RW — 64-bit element
11	00	LD1RSB — 64-bit element
11	01	LD1RSB — 32-bit element
11	10	LD1RSB — 16-bit element
11	11	LD1RD

SVE 32-bit gather load (scalar plus 32-bit unscaled offsets)

These instructions are under SVE Memory - 32-bit Gather and Unsized Contiguous.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	0	0	0	1	0	msz		xs	0	Zm					0	U	ff	Pg			Rn					Zt				

Decode fields msz	xs	U	ff	Zt	Instruction Details
00		0	0		LD1SB (scalar plus vector)
00		0	1		LDFF1SB (scalar plus vector)
00		1	0		LD1B (scalar plus vector)
00		1	1		LDFF1B (scalar plus vector)
01		0	0		LD1SH (scalar plus vector)
01		0	1		LDFF1SH (scalar plus vector)
01		1	0		LD1H (scalar plus vector)
01		1	1		LDFF1H (scalar plus vector)
10		0			UNALLOCATED
10		1	0		LD1W (scalar plus vector)
10		1	1		LDFF1W (scalar plus vector)
11	0		1		UNALLOCATED
11	0	0	0	1xxxx	UNALLOCATED
11	1			1xxxx	UNALLOCATED

SVE Memory - Contiguous Load

These instructions are under SVE encodings.

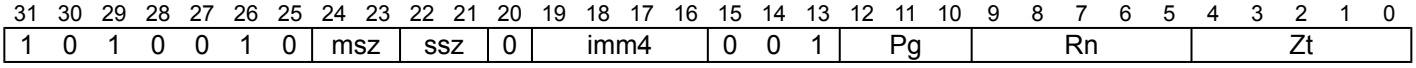
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1010010											op0					op1																

Decode fields op0	op1	Instruction details

0	001	SVE load and broadcast quadword (scalar plus immediate)
0	101	SVE contiguous load (scalar plus immediate)
0	111	SVE load multiple structures (scalar plus immediate)
1	001	UNALLOCATED
1	101	SVE contiguous non-fault load (scalar plus immediate)
1	111	UNALLOCATED
	000	SVE load and broadcast quadword (scalar plus scalar)
	010	SVE contiguous load (scalar plus scalar)
	011	SVE contiguous first-fault load (scalar plus scalar)
	100	UNALLOCATED
	110	SVE load multiple structures (scalar plus scalar)

SVE load and broadcast quadword (scalar plus immediate)

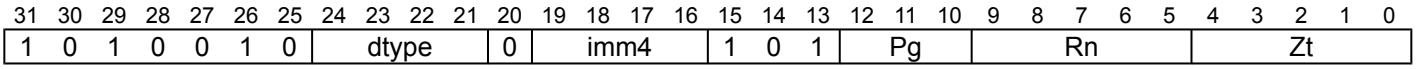
These instructions are under SVE Memory - Contiguous Load.



Decode fields msz	ssz	Instruction Details
	01	UNALLOCATED
	1x	UNALLOCATED
00	00	LD1RQB (scalar plus immediate)
01	00	LD1RQH (scalar plus immediate)
10	00	LD1RQW (scalar plus immediate)
11	00	LD1RQD (scalar plus immediate)

SVE contiguous load (scalar plus immediate)

These instructions are under SVE Memory - Contiguous Load.

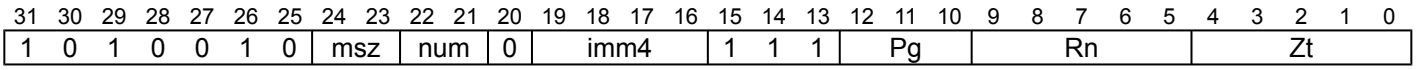


Decode fields dtype	Instruction Details
0000	LD1B (scalar plus immediate) — 8-bit element
0001	LD1B (scalar plus immediate) — 16-bit element
0010	LD1B (scalar plus immediate) — 32-bit element
0011	LD1B (scalar plus immediate) — 64-bit element
0100	LD1SW (scalar plus immediate)
0101	LD1H (scalar plus immediate) — 16-bit element
0110	LD1H (scalar plus immediate) — 32-bit element
0111	LD1H (scalar plus immediate) — 64-bit element
1000	LD1SH (scalar plus immediate) — 64-bit element
1001	LD1SH (scalar plus immediate) — 32-bit element
1010	LD1W (scalar plus immediate) — 32-bit element
1011	LD1W (scalar plus immediate) — 64-bit element
1100	LD1SB (scalar plus immediate) — 64-bit element
1101	LD1SB (scalar plus immediate) — 32-bit element
1110	LD1SB (scalar plus immediate) — 16-bit element

Decode fields dtype	Instruction Details
1111	LD1D (scalar plus immediate)

SVE load multiple structures (scalar plus immediate)

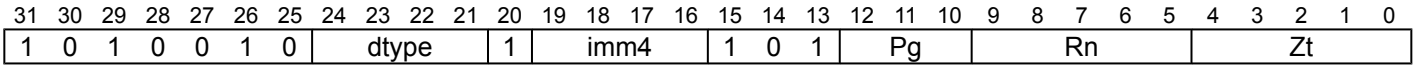
These instructions are under SVE Memory - Contiguous Load.



Decode fields msz	num	Instruction Details
00	01	LD2B (scalar plus immediate)
00	10	LD3B (scalar plus immediate)
00	11	LD4B (scalar plus immediate)
01	01	LD2H (scalar plus immediate)
01	10	LD3H (scalar plus immediate)
01	11	LD4H (scalar plus immediate)
10	01	LD2W (scalar plus immediate)
10	10	LD3W (scalar plus immediate)
10	11	LD4W (scalar plus immediate)
11	01	LD2D (scalar plus immediate)
11	10	LD3D (scalar plus immediate)
11	11	LD4D (scalar plus immediate)

SVE contiguous non-fault load (scalar plus immediate)

These instructions are under SVE Memory - Contiguous Load.



Decode fields dtype	Instruction Details
0000	LDNF1B — 8-bit element
0001	LDNF1B — 16-bit element
0010	LDNF1B — 32-bit element
0011	LDNF1B — 64-bit element
0100	LDNF1SW
0101	LDNF1H — 16-bit element
0110	LDNF1H — 32-bit element
0111	LDNF1H — 64-bit element
1000	LDNF1SH — 64-bit element
1001	LDNF1SH — 32-bit element
1010	LDNF1W — 32-bit element
1011	LDNF1W — 64-bit element
1100	LDNF1SB — 64-bit element
1101	LDNF1SB — 32-bit element
1110	LDNF1SB — 16-bit element
1111	LDNF1D

SVE load and broadcast quadword (scalar plus scalar)

These instructions are under SVE Memory - Contiguous Load.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	0	0	1	0	msz		ssz		Rm					0	0	0	Pg			Rn					Zt				

Decode fields msz	ssz	Instruction Details
	01	UNALLOCATED
	1x	UNALLOCATED
00	00	LD1RQB (scalar plus scalar)
01	00	LD1RQH (scalar plus scalar)
10	00	LD1RQW (scalar plus scalar)
11	00	LD1RQD (scalar plus scalar)

SVE contiguous load (scalar plus scalar)

These instructions are under SVE Memory - Contiguous Load.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	0	0	1	0	dtype				Rm					0	1	0	Pg			Rn					Zt				

Decode fields dtype	Instruction Details
0000	LD1B (scalar plus scalar) — 8-bit element
0001	LD1B (scalar plus scalar) — 16-bit element
0010	LD1B (scalar plus scalar) — 32-bit element
0011	LD1B (scalar plus scalar) — 64-bit element
0100	LD1SW (scalar plus scalar)
0101	LD1H (scalar plus scalar) — 16-bit element
0110	LD1H (scalar plus scalar) — 32-bit element
0111	LD1H (scalar plus scalar) — 64-bit element
1000	LD1SH (scalar plus scalar) — 64-bit element
1001	LD1SH (scalar plus scalar) — 32-bit element
1010	LD1W (scalar plus scalar) — 32-bit element
1011	LD1W (scalar plus scalar) — 64-bit element
1100	LD1SB (scalar plus scalar) — 64-bit element
1101	LD1SB (scalar plus scalar) — 32-bit element
1110	LD1SB (scalar plus scalar) — 16-bit element
1111	LD1D (scalar plus scalar)

SVE contiguous first-fault load (scalar plus scalar)

These instructions are under SVE Memory - Contiguous Load.

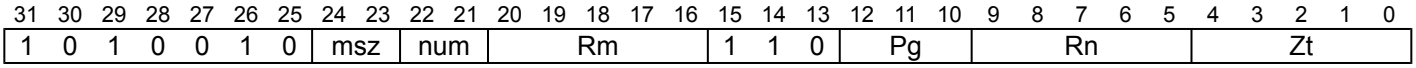
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	0	0	1	0	dtype				Rm					0	1	1	Pg			Rn					Zt				

Decode fields dtype	Instruction Details
0000	LDFF1B (scalar plus scalar) — 8-bit element
0001	LDFF1B (scalar plus scalar) — 16-bit element
0010	LDFF1B (scalar plus scalar) — 32-bit element
0011	LDFF1B (scalar plus scalar) — 64-bit element

Decode fields dtype	Instruction Details
0100	LDFF1SW (scalar plus scalar)
0101	LDFF1H (scalar plus scalar) — 16-bit element
0110	LDFF1H (scalar plus scalar) — 32-bit element
0111	LDFF1H (scalar plus scalar) — 64-bit element
1000	LDFF1SH (scalar plus scalar) — 64-bit element
1001	LDFF1SH (scalar plus scalar) — 32-bit element
1010	LDFF1W (scalar plus scalar) — 32-bit element
1011	LDFF1W (scalar plus scalar) — 64-bit element
1100	LDFF1SB (scalar plus scalar) — 64-bit element
1101	LDFF1SB (scalar plus scalar) — 32-bit element
1110	LDFF1SB (scalar plus scalar) — 16-bit element
1111	LDFF1D (scalar plus scalar)

SVE load multiple structures (scalar plus scalar)

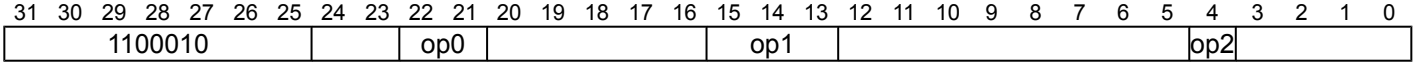
These instructions are under SVE Memory - Contiguous Load.



Decode fields msz	num	Instruction Details
00	01	LD2B (scalar plus scalar)
00	10	LD3B (scalar plus scalar)
00	11	LD4B (scalar plus scalar)
01	01	LD2H (scalar plus scalar)
01	10	LD3H (scalar plus scalar)
01	11	LD4H (scalar plus scalar)
10	01	LD2W (scalar plus scalar)
10	10	LD3W (scalar plus scalar)
10	11	LD4W (scalar plus scalar)
11	01	LD2D (scalar plus scalar)
11	10	LD3D (scalar plus scalar)
11	11	LD4D (scalar plus scalar)

SVE Memory - 64-bit Gather

These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
00	101		UNALLOCATED
00	111	0	SVE 64-bit gather prefetch (vector plus immediate)
00	111	1	UNALLOCATED
00	1x0		SVE2 64-bit gather non-temporal load (scalar plus unpacked 32-bit unscaled offsets)
01	1xx		SVE 64-bit gather load (vector plus immediate)
10	1xx		SVE 64-bit gather load (scalar plus 64-bit unscaled offsets)

11	1xx		SVE 64-bit gather load (scalar plus 64-bit scaled offsets)
x0	0xx		SVE 64-bit gather load (scalar plus unpacked 32-bit unscaled offsets)
x1	0xx		SVE 64-bit gather load (scalar plus 32-bit unpacked scaled offsets)

SVE 64-bit gather prefetch (vector plus immediate)

These instructions are under SVE Memory - 64-bit Gather.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	1	0	msz		0	0	imm5					1	1	1	Pg			Zn					0	prfop			

Decode fields msz	Instruction Details
00	PRFB (vector plus immediate)
01	PRFH (vector plus immediate)
10	PRFW (vector plus immediate)
11	PRFD (vector plus immediate)

SVE2 64-bit gather non-temporal load (scalar plus unpacked 32-bit unscaled offsets)

These instructions are under SVE Memory - 64-bit Gather.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	1	0	msz		0	0	Rm					1	U	0	Pg			Zn					Zt				

Decode fields msz	U	Instruction Details
00	0	LDNT1SB
00	1	LDNT1B (vector plus scalar)
01	0	LDNT1SH
01	1	LDNT1H (vector plus scalar)
10	0	LDNT1SW
10	1	LDNT1W (vector plus scalar)
11	0	UNALLOCATED
11	1	LDNT1D (vector plus scalar)

SVE 64-bit gather load (vector plus immediate)

These instructions are under SVE Memory - 64-bit Gather.

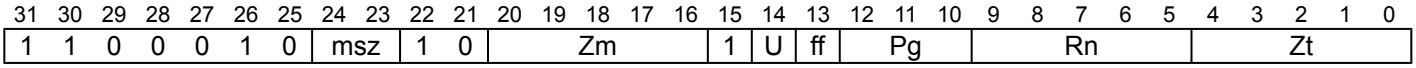
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	1	0	msz		0	1	imm5					1	U	ff	Pg			Zn					Zt				

Decode fields msz	U	ff	Instruction Details
00	0	0	LD1SB (vector plus immediate)
00	0	1	LDFF1SB (vector plus immediate)
00	1	0	LD1B (vector plus immediate)
00	1	1	LDFF1B (vector plus immediate)
01	0	0	LD1SH (vector plus immediate)
01	0	1	LDFF1SH (vector plus immediate)
01	1	0	LD1H (vector plus immediate)
01	1	1	LDFF1H (vector plus immediate)

Decode fields msz	U	ff	Instruction Details
10	0	0	LD1SW (vector plus immediate)
10	0	1	LDFF1SW (vector plus immediate)
10	1	0	LD1W (vector plus immediate)
10	1	1	LDFF1W (vector plus immediate)
11	0		UNALLOCATED
11	1	0	LD1D (vector plus immediate)
11	1	1	LDFF1D (vector plus immediate)

SVE 64-bit gather load (scalar plus 64-bit unscaled offsets)

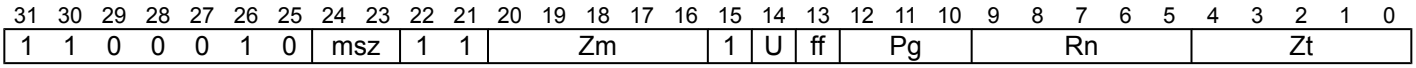
These instructions are under SVE Memory - 64-bit Gather.



Decode fields msz	U	ff	Instruction Details
00	0	0	LD1SB (scalar plus vector)
00	0	1	LDFF1SB (scalar plus vector)
00	1	0	LD1B (scalar plus vector)
00	1	1	LDFF1B (scalar plus vector)
01	0	0	LD1SH (scalar plus vector)
01	0	1	LDFF1SH (scalar plus vector)
01	1	0	LD1H (scalar plus vector)
01	1	1	LDFF1H (scalar plus vector)
10	0	0	LD1SW (scalar plus vector)
10	0	1	LDFF1SW (scalar plus vector)
10	1	0	LD1W (scalar plus vector)
10	1	1	LDFF1W (scalar plus vector)
11	0		UNALLOCATED
11	1	0	LD1D (scalar plus vector)
11	1	1	LDFF1D (scalar plus vector)

SVE 64-bit gather load (scalar plus 64-bit scaled offsets)

These instructions are under SVE Memory - 64-bit Gather.



Decode fields msz	U	ff	Zt	Instruction Details
00			1xxxx	UNALLOCATED
01	0	0		LD1SH (scalar plus vector)
01	0	1		LDFF1SH (scalar plus vector)
01	1	0		LD1H (scalar plus vector)
01	1	1		LDFF1H (scalar plus vector)
10	0	0		LD1SW (scalar plus vector)
10	0	1		LDFF1SW (scalar plus vector)
10	1	0		LD1W (scalar plus vector)

Decode fields				Instruction Details
msz	U	ff	Zt	
10	1	1		LDFF1W (scalar plus vector)
11	0			UNALLOCATED
11	1	0		LD1D (scalar plus vector)
11	1	1		LDFF1D (scalar plus vector)

SVE 64-bit gather load (scalar plus unpacked 32-bit unscaled offsets)

These instructions are under SVE Memory - 64-bit Gather.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	1	0	msz		xs	0	Zm					0	U	ff	Pg			Rn					Zt				

Decode fields			Instruction Details
msz	U	ff	
00	0	0	LD1SB (scalar plus vector)
00	0	1	LDFF1SB (scalar plus vector)
00	1	0	LD1B (scalar plus vector)
00	1	1	LDFF1B (scalar plus vector)
01	0	0	LD1SH (scalar plus vector)
01	0	1	LDFF1SH (scalar plus vector)
01	1	0	LD1H (scalar plus vector)
01	1	1	LDFF1H (scalar plus vector)
10	0	0	LD1SW (scalar plus vector)
10	0	1	LDFF1SW (scalar plus vector)
10	1	0	LD1W (scalar plus vector)
10	1	1	LDFF1W (scalar plus vector)
11	0		UNALLOCATED
11	1	0	LD1D (scalar plus vector)
11	1	1	LDFF1D (scalar plus vector)

SVE 64-bit gather load (scalar plus 32-bit unpacked scaled offsets)

These instructions are under SVE Memory - 64-bit Gather.

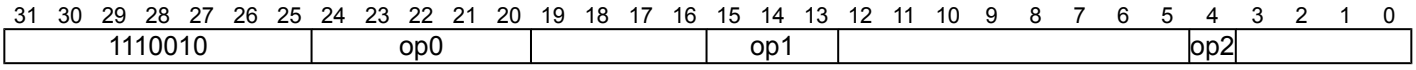
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	0	0	1	0	msz		xs	1	Zm					0	U	ff	Pg			Rn					Zt				

Decode fields				Instruction Details
msz	U	ff	Zt	
00			1xxxx	UNALLOCATED
01	0	0		LD1SH (scalar plus vector)
01	0	1		LDFF1SH (scalar plus vector)
01	1	0		LD1H (scalar plus vector)
01	1	1		LDFF1H (scalar plus vector)
10	0	0		LD1SW (scalar plus vector)
10	0	1		LDFF1SW (scalar plus vector)
10	1	0		LD1W (scalar plus vector)
10	1	1		LDFF1W (scalar plus vector)
11	0			UNALLOCATED
11	1	0		LD1D (scalar plus vector)

Decode fields msz	U	ff	Zt	Instruction Details
11	1	1		LDFF1D (scalar plus vector)

SVE Memory - Store

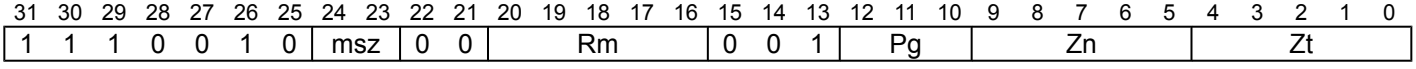
These instructions are under SVE encodings.



Decode fields op0	op1	op2	Instruction details
0xx0x	000		UNALLOCATED
0xx1x	00x		UNALLOCATED
10x0x	000		UNALLOCATED
10x1x	00x		UNALLOCATED
1101x	001		UNALLOCATED
110xx	000	0	STR (predicate)
110xx	000	1	UNALLOCATED
1110x	000		UNALLOCATED
1111x	00x		UNALLOCATED
xx00x	001		SVE2 64-bit scatter non-temporal store (vector plus scalar)
xx00x	101		SVE 64-bit scatter store (scalar plus 64-bit unscaled offsets)
xx00x	1x0		SVE 64-bit scatter store (scalar plus unpacked 32-bit unscaled offsets)
xx01x	101		SVE 64-bit scatter store (scalar plus 64-bit scaled offsets)
xx01x	1x0		SVE 64-bit scatter store (scalar plus unpacked 32-bit scaled offsets)
xx10x	001		SVE2 32-bit scatter non-temporal store (vector plus scalar)
xx10x	101		SVE 64-bit scatter store (vector plus immediate)
xx10x	1x0		SVE 32-bit scatter store (scalar plus 32-bit unscaled offsets)
xx11x	101		SVE 32-bit scatter store (vector plus immediate)
xx11x	1x0		SVE 32-bit scatter store (scalar plus 32-bit scaled offsets)
xxxx0	111		SVE contiguous store (scalar plus immediate)
xxxx1	111		SVE store multiple structures (scalar plus immediate)
	010		SVE contiguous store (scalar plus scalar)
	011		SVE store multiple structures (scalar plus scalar)

SVE2 64-bit scatter non-temporal store (vector plus scalar)

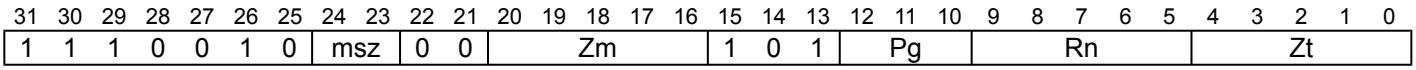
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	STNT1B (vector plus scalar)
01	STNT1H (vector plus scalar)
10	STNT1W (vector plus scalar)
11	STNT1D (vector plus scalar)

SVE 64-bit scatter store (scalar plus 64-bit unscaled offsets)

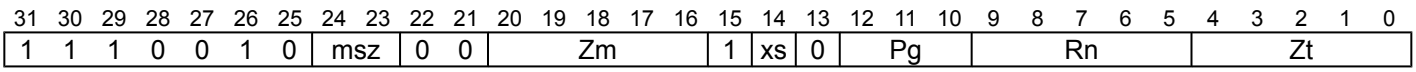
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	ST1B (scalar plus vector)
01	ST1H (scalar plus vector)
10	ST1W (scalar plus vector)
11	ST1D (scalar plus vector)

SVE 64-bit scatter store (scalar plus unpacked 32-bit unscaled offsets)

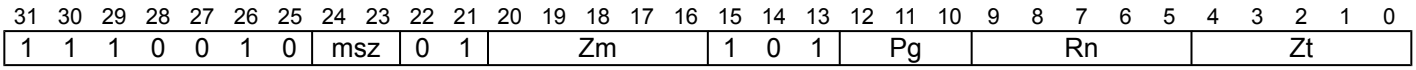
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	ST1B (scalar plus vector)
01	ST1H (scalar plus vector)
10	ST1W (scalar plus vector)
11	ST1D (scalar plus vector)

SVE 64-bit scatter store (scalar plus 64-bit scaled offsets)

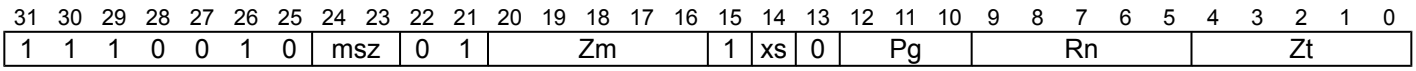
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	UNALLOCATED
01	ST1H (scalar plus vector)
10	ST1W (scalar plus vector)
11	ST1D (scalar plus vector)

SVE 64-bit scatter store (scalar plus unpacked 32-bit scaled offsets)

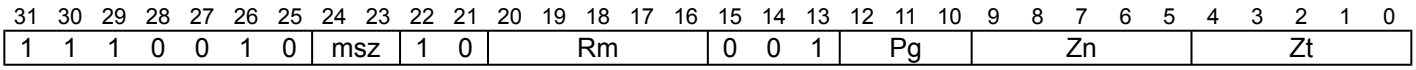
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	UNALLOCATED
01	ST1H (scalar plus vector)
10	ST1W (scalar plus vector)
11	ST1D (scalar plus vector)

SVE2 32-bit scatter non-temporal store (vector plus scalar)

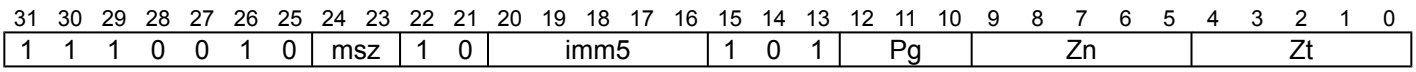
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	STNT1B (vector plus scalar)
01	STNT1H (vector plus scalar)
10	STNT1W (vector plus scalar)
11	UNALLOCATED

SVE 64-bit scatter store (vector plus immediate)

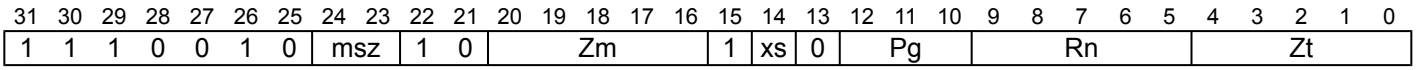
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	ST1B (vector plus immediate)
01	ST1H (vector plus immediate)
10	ST1W (vector plus immediate)
11	ST1D (vector plus immediate)

SVE 32-bit scatter store (scalar plus 32-bit unscaled offsets)

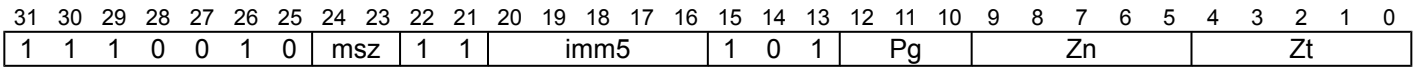
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	ST1B (scalar plus vector)
01	ST1H (scalar plus vector)
10	ST1W (scalar plus vector)
11	UNALLOCATED

SVE 32-bit scatter store (vector plus immediate)

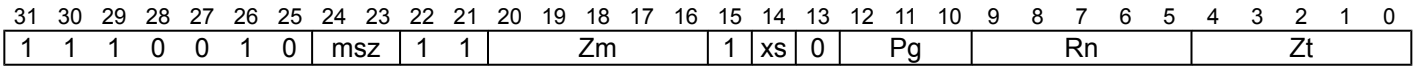
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	ST1B (vector plus immediate)
01	ST1H (vector plus immediate)
10	ST1W (vector plus immediate)
11	UNALLOCATED

SVE 32-bit scatter store (scalar plus 32-bit scaled offsets)

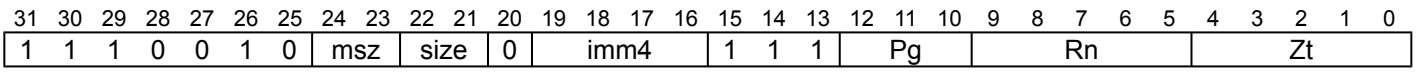
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	UNALLOCATED
01	ST1H (scalar plus vector)
10	ST1W (scalar plus vector)
11	UNALLOCATED

SVE contiguous store (scalar plus immediate)

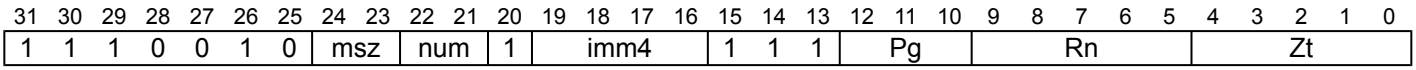
These instructions are under SVE Memory - Store.



Decode fields msz	Instruction Details
00	ST1B (scalar plus immediate)
01	ST1H (scalar plus immediate)
10	ST1W (scalar plus immediate)
11	ST1D (scalar plus immediate)

SVE store multiple structures (scalar plus immediate)

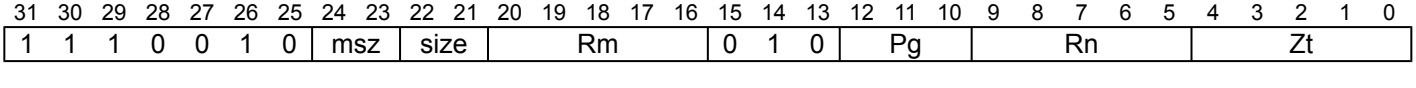
These instructions are under SVE Memory - Store.



Decode fields msz	num	Instruction Details
00	01	ST2B (scalar plus immediate)
00	10	ST3B (scalar plus immediate)
00	11	ST4B (scalar plus immediate)
01	01	ST2H (scalar plus immediate)
01	10	ST3H (scalar plus immediate)
01	11	ST4H (scalar plus immediate)
10	01	ST2W (scalar plus immediate)
10	10	ST3W (scalar plus immediate)
10	11	ST4W (scalar plus immediate)
11	01	ST2D (scalar plus immediate)
11	10	ST3D (scalar plus immediate)
11	11	ST4D (scalar plus immediate)

SVE contiguous store (scalar plus scalar)

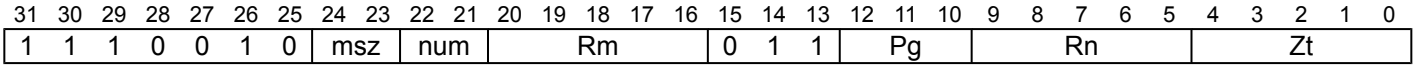
These instructions are under SVE Memory - Store.



Decode fields msz	size	Instruction Details
00		ST1B (scalar plus scalar)
01		ST1H (scalar plus scalar)
10		ST1W (scalar plus scalar)
11	10	UNALLOCATED
11	11	ST1D (scalar plus scalar)

SVE store multiple structures (scalar plus scalar)

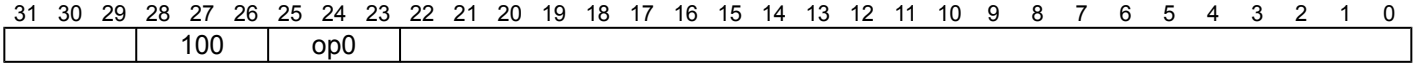
These instructions are under SVE Memory - Store.



Decode fields msz	num	Instruction Details
00	01	ST2B (scalar plus scalar)
00	10	ST3B (scalar plus scalar)
00	11	ST4B (scalar plus scalar)
01	01	ST2H (scalar plus scalar)
01	10	ST3H (scalar plus scalar)
01	11	ST4H (scalar plus scalar)
10	01	ST2W (scalar plus scalar)
10	10	ST3W (scalar plus scalar)
10	11	ST4W (scalar plus scalar)
11	01	ST2D (scalar plus scalar)
11	10	ST3D (scalar plus scalar)
11	11	ST4D (scalar plus scalar)

Data Processing -- Immediate

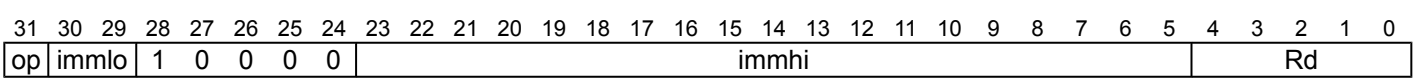
These instructions are under the top-level.



Decode fields op0	Instruction details
00x	PC-rel. addressing
010	Add/subtract (immediate)
011	Add/subtract (immediate, with tags)
100	Logical (immediate)
101	Move wide (immediate)
110	Bitfield
111	Extract

PC-rel. addressing

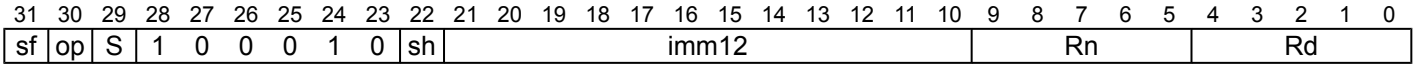
These instructions are under Data Processing -- Immediate.



Decode fields op	Instruction Details
0	ADR
1	ADRP

Add/subtract (immediate)

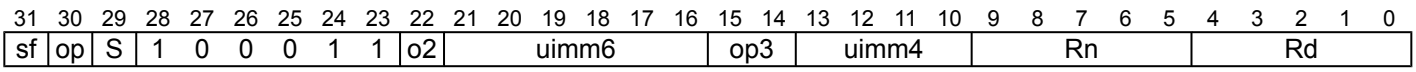
These instructions are under Data Processing -- Immediate.



Decode fields sf	op	S	Instruction Details
0	0	0	ADD (immediate) — 32-bit
0	0	1	ADDS (immediate) — 32-bit
0	1	0	SUB (immediate) — 32-bit
0	1	1	SUBS (immediate) — 32-bit
1	0	0	ADD (immediate) — 64-bit
1	0	1	ADDS (immediate) — 64-bit
1	1	0	SUB (immediate) — 64-bit
1	1	1	SUBS (immediate) — 64-bit

Add/subtract (immediate, with tags)

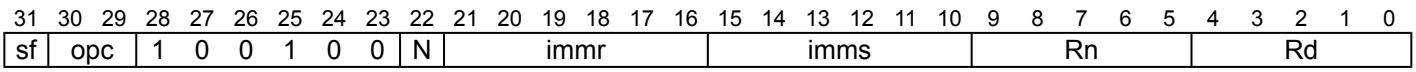
These instructions are under Data Processing -- Immediate.



Decode fields sf	op	S	Instruction Details	Architecture Version
0			UNALLOCATED	-
1		1	UNALLOCATED	-
1	0	0	ADDG	Armv8.5
1	1	0	SUBG	Armv8.5

Logical (immediate)

These instructions are under Data Processing -- Immediate.

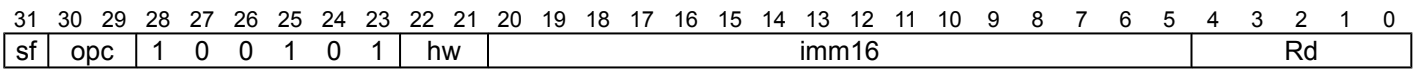


Decode fields sf	opc	N	Instruction Details
0		1	UNALLOCATED
0	00	0	AND (immediate) — 32-bit
0	01	0	ORR (immediate) — 32-bit
0	10	0	EOR (immediate) — 32-bit
0	11	0	ANDS (immediate) — 32-bit
1	00		AND (immediate) — 64-bit
1	01		ORR (immediate) — 64-bit
1	10		EOR (immediate) — 64-bit

Decode fields			Instruction Details
sf	opc	N	
1	11		ANDS (immediate) — 64-bit

Move wide (immediate)

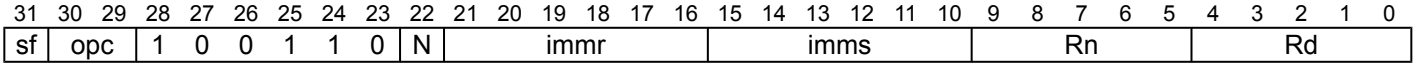
These instructions are under Data Processing -- Immediate.



Decode fields			Instruction Details
sf	opc	hw	
	01		UNALLOCATED
0		1x	UNALLOCATED
0	00		MOVN — 32-bit
0	10		MOVZ — 32-bit
0	11		MOVK — 32-bit
1	00		MOVN — 64-bit
1	10		MOVZ — 64-bit
1	11		MOVK — 64-bit

Bitfield

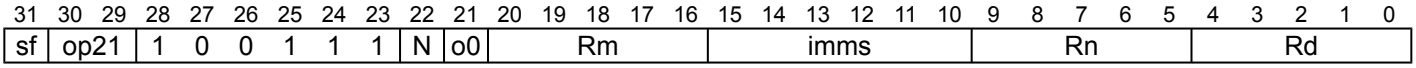
These instructions are under Data Processing -- Immediate.



Decode fields			Instruction Details
sf	opc	N	
	11		UNALLOCATED
0		1	UNALLOCATED
0	00	0	SBFM — 32-bit
0	01	0	BFM — 32-bit
0	10	0	UBFM — 32-bit
1		0	UNALLOCATED
1	00	1	SBFM — 64-bit
1	01	1	BFM — 64-bit
1	10	1	UBFM — 64-bit

Extract

These instructions are under Data Processing -- Immediate.

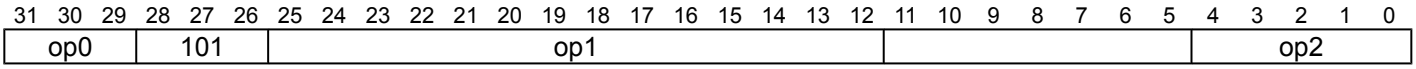


Decode fields					Instruction Details
sf	op21	N	o0	imms	
	x1				UNALLOCATED
	00		1		UNALLOCATED
	1x				UNALLOCATED
0				1xxxxx	UNALLOCATED

Decode fields					Instruction Details
sf	op21	N	o0	imms	
0		1			UNALLOCATED
0	00	0	0	0xxxxx	EXTR — 32-bit
1		0			UNALLOCATED
1	00	1	0		EXTR — 64-bit

Branches, Exception Generating and System instructions

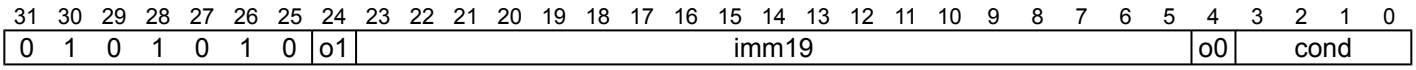
These instructions are under the top-level.



Decode fields			Instruction details
op0	op1	op2	
010	0xxxxxxxxxxxxx		Conditional branch (immediate)
110	00xxxxxxxxxxxx		Exception generation
110	01000000110010	11111	Hints
110	01000000110011		Barriers
110	0100000xxx0100		PSTATE
110	0100100xxxxxxx		System with result
110	0100x01xxxxxxx		System instructions
110	0100x1xxxxxxxx		System register move
110	1xxxxxxxxxxxxx		Unconditional branch (register)
x00			Unconditional branch (immediate)
x01	0xxxxxxxxxxxxx		Compare and branch (immediate)
x01	1xxxxxxxxxxxxx		Test and branch (immediate)

Conditional branch (immediate)

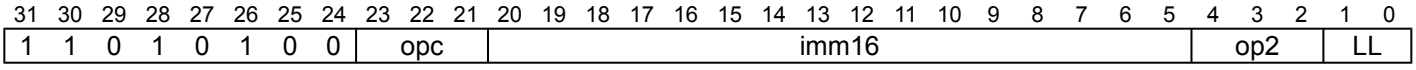
These instructions are under Branches, Exception Generating and System instructions.



Decode fields		Instruction Details
o1	o0	
0	0	B.cond
0	1	UNALLOCATED
1		UNALLOCATED

Exception generation

These instructions are under Branches, Exception Generating and System instructions.



Decode fields			Instruction Details	Architecture Version
opc	op2	LL		
	xx1		UNALLOCATED	-
	x1x		UNALLOCATED	-
	1xx		UNALLOCATED	-

Decode fields opc	op2	LL	Instruction Details	Architecture Version
000	000	00	UNALLOCATED	-
000	000	01	SVC	-
000	000	10	HVC	-
000	000	11	SMC	-
001	000	x1	UNALLOCATED	-
001	000	00	BRK	-
001	000	1x	UNALLOCATED	-
010	000	x1	UNALLOCATED	-
010	000	00	HLT	-
010	000	1x	UNALLOCATED	-
011	000	00	TCANCEL	TME
011	000	01	UNALLOCATED	-
011	000	1x	UNALLOCATED	-
100	000	00	UNALLOCATED	-
101	000	00	UNALLOCATED	-
101	000	01	DCPS1	-
101	000	10	DCPS2	-
101	000	11	DCPS3	-
110	000		UNALLOCATED	-
111	000	01	UNALLOCATED	-
111	000	1x	UNALLOCATED	-

Hints

These instructions are under Branches, Exception Generating and System instructions.

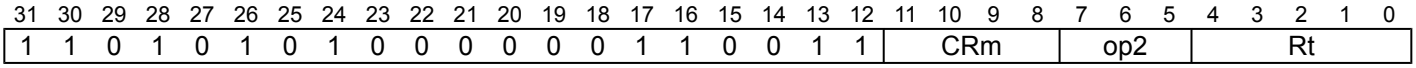
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	0	1	0	1	0	0	0	0	0	0	1	1	0	0	1	0	CRm				op2			1	1	1	1	1

Decode fields CRm	op2	Instruction Details	Architecture Version
		HINT	-
0000	000	NOP	-
0000	001	YIELD	-
0000	010	WFE	-
0000	011	WFI	-
0000	100	SEV	-
0000	101	SEVL	-
0000	111	XPACD, XPACI, XPACLRI	Armv8.3
0001	000	PACIA, PACIA1716, PACIASP, PACIAZ, PACIZA — PACIA1716	Armv8.3
0001	010	PACIB, PACIB1716, PACIBSP, PACIBZ, PACIZB — PACIB1716	Armv8.3
0001	100	AUTIA, AUTIA1716, AUTIASP, AUTIAZ, AUTIZA — AUTIA1716	Armv8.3
0001	110	AUTIB, AUTIB1716, AUTIBSP, AUTIBZ, AUTIZB — AUTIB1716	Armv8.3
0010	000	ESB	Armv8.2
0010	001	PSB CSYNC	Armv8.2
0010	010	TSB CSYNC	Armv8.4
0010	100	CSDB	-
0011	000	PACIA, PACIA1716, PACIASP, PACIAZ, PACIZA — PACIAZ	Armv8.3
0011	001	PACIA, PACIA1716, PACIASP, PACIAZ, PACIZA — PACIASP	Armv8.3

Decode fields CRm	op2	Instruction Details	Architecture Version
0011	010	PACIB, PACIB1716, PACIBSP, PACIBZ, PACIZB — PACIBZ	Armv8.3
0011	011	PACIB, PACIB1716, PACIBSP, PACIBZ, PACIZB — PACIBSP	Armv8.3
0011	100	AUTIA, AUTIA1716, AUTIASP, AUTIAZ, AUTIZA — AUTIAZ	Armv8.3
0011	101	AUTIA, AUTIA1716, AUTIASP, AUTIAZ, AUTIZA — AUTIASP	Armv8.3
0011	110	AUTIB, AUTIB1716, AUTIBSP, AUTIBZ, AUTIZB — AUTIBZ	Armv8.3
0011	111	AUTIB, AUTIB1716, AUTIBSP, AUTIBZ, AUTIZB — AUTIBSP	Armv8.3
0100	xx0	BTI	Armv8.5

Barriers

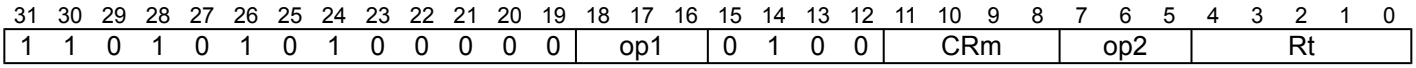
These instructions are under Branches, Exception Generating and System instructions.



CRm	Decode fields op2	Rt	Instruction Details	Architecture Version
	000		UNALLOCATED	-
	001		UNALLOCATED	-
	010	11111	CLREX	-
	101	11111	DMB	-
	110	11111	ISB	-
	111	!= 11111	UNALLOCATED	-
	111	11111	SB	-
!= 0x00	100	11111	DSB	-
0000	011	11111	TCOMMIT	TME
0000	100	11111	SSBB	-
0001	011		UNALLOCATED	-
001x	011		UNALLOCATED	-
01xx	011		UNALLOCATED	-
0100	100	11111	PSSBB	-
1xxx	011		UNALLOCATED	-

PSTATE

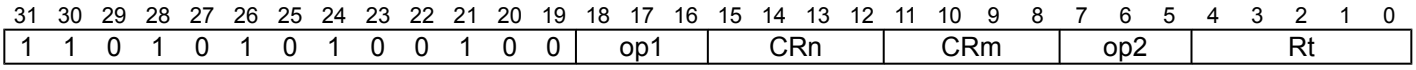
These instructions are under Branches, Exception Generating and System instructions.



op1	Decode fields op2	Rt	Instruction Details	Architecture Version
		!= 11111	UNALLOCATED	-
		11111	MSR (immediate)	-
000	000	11111	CFINV	Armv8.4
000	001	11111	XAFLAG~~XAFlag~~	Armv8.5
000	010	11111	AXFLAG~~AXFlag~~	Armv8.5

System with result

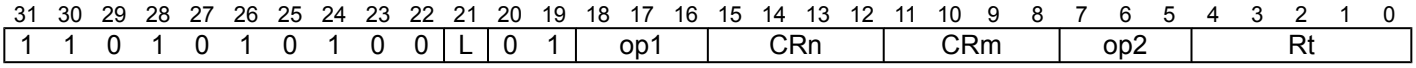
These instructions are under Branches, Exception Generating and System instructions.



Decode fields				Instruction Details	Architecture Version
op1	CRn	CRm	op2		
!= 011				UNALLOCATED	-
011	!= 0011			UNALLOCATED	-
011	0011		!= 011	UNALLOCATED	-
011	0011	!= 000x	011	UNALLOCATED	-
011	0011	0000	011	TSTART	TME
011	0011	0001	011	TTEST	TME

System instructions

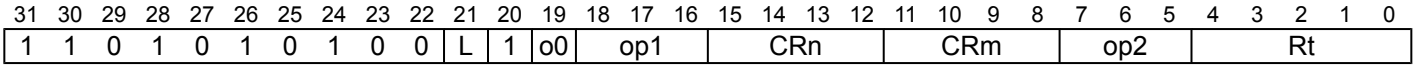
These instructions are under Branches, Exception Generating and System instructions.



Decode fields	Instruction Details
L	
0	SYS
1	SYSL

System register move

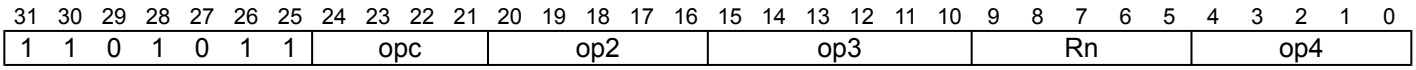
These instructions are under Branches, Exception Generating and System instructions.



Decode fields	Instruction Details
L	
0	MSR (register)
1	MRS

Unconditional branch (register)

These instructions are under Branches, Exception Generating and System instructions.



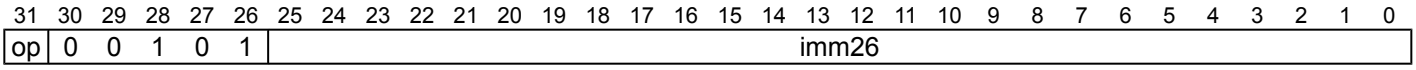
Decode fields					Instruction Details	Architecture Version
opc	op2	op3	Rn	op4		
	!= 11111				UNALLOCATED	-
0000	11111	000000		!= 00000	UNALLOCATED	-
0000	11111	000000		00000	BR	-
0000	11111	000001			UNALLOCATED	-
0000	11111	000010		!= 11111	UNALLOCATED	-
0000	11111	000010		11111	BRAA, BRAAZ, BRAB, BRABZ — key A, zero modifier	Armv8.3

Decode fields					Instruction Details	Architecture Version
opc	op2	op3	Rn	op4		
0000	11111	000011		!= 11111	UNALLOCATED	-
0000	11111	000011		11111	BRAA, BRAAZ, BRAB, BRABZ — key B, zero modifier	Armv8.3
0000	11111	0001xx			UNALLOCATED	-
0000	11111	001xxx			UNALLOCATED	-
0000	11111	01xxxx			UNALLOCATED	-
0000	11111	1xxxxx			UNALLOCATED	-
0001	11111	000000		!= 00000	UNALLOCATED	-
0001	11111	000000		00000	BLR	-
0001	11111	000001			UNALLOCATED	-
0001	11111	000010		!= 11111	UNALLOCATED	-
0001	11111	000010		11111	BLRAA, BLRAAZ, BLRAB, BLRABZ — key A, zero modifier	Armv8.3
0001	11111	000011		!= 11111	UNALLOCATED	-
0001	11111	000011		11111	BLRAA, BLRAAZ, BLRAB, BLRABZ — key B, zero modifier	Armv8.3
0001	11111	0001xx			UNALLOCATED	-
0001	11111	001xxx			UNALLOCATED	-
0001	11111	01xxxx			UNALLOCATED	-
0001	11111	1xxxxx			UNALLOCATED	-
0010	11111	000000		!= 00000	UNALLOCATED	-
0010	11111	000000		00000	RET	-
0010	11111	000001			UNALLOCATED	-
0010	11111	000010	!= 11111	!= 11111	UNALLOCATED	-
0010	11111	000010	11111	11111	RETAA, RETAB — RETAA	Armv8.3
0010	11111	000011	!= 11111	!= 11111	UNALLOCATED	-
0010	11111	000011	11111	11111	RETAA, RETAB — RETAB	Armv8.3
0010	11111	0001xx			UNALLOCATED	-
0010	11111	001xxx			UNALLOCATED	-
0010	11111	01xxxx			UNALLOCATED	-
0010	11111	1xxxxx			UNALLOCATED	-
0011	11111				UNALLOCATED	-
0100	11111	000000	!= 11111	!= 00000	UNALLOCATED	-
0100	11111	000000	!= 11111	00000	UNALLOCATED	-
0100	11111	000000	11111	!= 00000	UNALLOCATED	-
0100	11111	000000	11111	00000	ERET	-
0100	11111	000001			UNALLOCATED	-
0100	11111	000010	!= 11111	!= 11111	UNALLOCATED	-

Decode fields					Instruction Details	Architecture Version
opc	op2	op3	Rn	op4		
0100	11111	000010	!= 11111	11111	UNALLOCATED	-
0100	11111	000010	11111	!= 11111	UNALLOCATED	-
0100	11111	000010	11111	11111	ERETAA, ERETAB — ERETAA	Armv8.3
0100	11111	000011	!= 11111	!= 11111	UNALLOCATED	-
0100	11111	000011	!= 11111	11111	UNALLOCATED	-
0100	11111	000011	11111	!= 11111	UNALLOCATED	-
0100	11111	000011	11111	11111	ERETAA, ERETAB — ERETAB	Armv8.3
0100	11111	0001xx			UNALLOCATED	-
0100	11111	001xxx			UNALLOCATED	-
0100	11111	01xxxx			UNALLOCATED	-
0100	11111	1xxxxx			UNALLOCATED	-
0101	11111	!= 000000			UNALLOCATED	-
0101	11111	000000	!= 11111	!= 00000	UNALLOCATED	-
0101	11111	000000	!= 11111	00000	UNALLOCATED	-
0101	11111	000000	11111	!= 00000	UNALLOCATED	-
0101	11111	000000	11111	00000	DRPS	-
011x	11111				UNALLOCATED	-
1000	11111	00000x			UNALLOCATED	-
1000	11111	000010			BRAA, BRAAZ, BRAB, BRABZ — key A, register modifier	Armv8.3
1000	11111	000011			BRAA, BRAAZ, BRAB, BRABZ — key B, register modifier	Armv8.3
1000	11111	0001xx			UNALLOCATED	-
1000	11111	001xxx			UNALLOCATED	-
1000	11111	01xxxx			UNALLOCATED	-
1000	11111	1xxxxx			UNALLOCATED	-
1001	11111	00000x			UNALLOCATED	-
1001	11111	000010			BLRAA, BLRAAZ, BLRAB, BLRABZ — key A, register modifier	Armv8.3
1001	11111	000011			BLRAA, BLRAAZ, BLRAB, BLRABZ — key B, register modifier	Armv8.3
1001	11111	0001xx			UNALLOCATED	-
1001	11111	001xxx			UNALLOCATED	-
1001	11111	01xxxx			UNALLOCATED	-
1001	11111	1xxxxx			UNALLOCATED	-
101x	11111				UNALLOCATED	-
11xx	11111				UNALLOCATED	-

Unconditional branch (immediate)

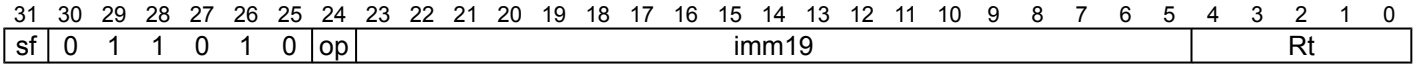
These instructions are under Branches, Exception Generating and System instructions.



Decode fields op	Instruction Details
0	B
1	BL

Compare and branch (immediate)

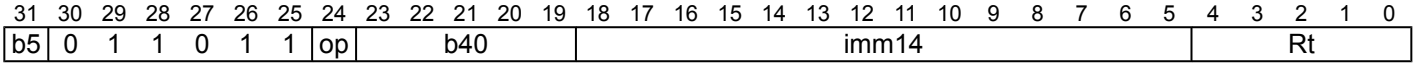
These instructions are under Branches, Exception Generating and System instructions.



Decode fields sf	op	Instruction Details
0	0	CBZ — 32-bit
0	1	CBNZ — 32-bit
1	0	CBZ — 64-bit
1	1	CBNZ — 64-bit

Test and branch (immediate)

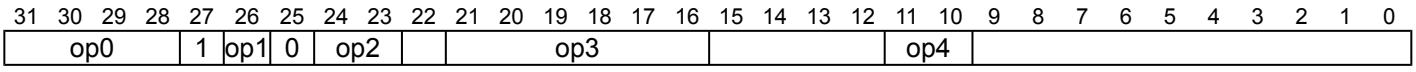
These instructions are under Branches, Exception Generating and System instructions.



Decode fields op	Instruction Details
0	TBZ
1	TBNZ

Loads and Stores

These instructions are under the top-level.



Decode fields op0	op1	op2	op3	op4	Instruction details
0x00	1	00	000000		Advanced SIMD load/store multiple structures
0x00	1	01	0xxxxx		Advanced SIMD load/store multiple structures (post-indexed)
0x00	1	0x	1xxxxx		UNALLOCATED
0x00	1	10	x00000		Advanced SIMD load/store single structure
0x00	1	11			Advanced SIMD load/store single structure (post-indexed)
0x00	1	x0	x1xxxx		UNALLOCATED
0x00	1	x0	xx1xxx		UNALLOCATED
0x00	1	x0	xxx1xx		UNALLOCATED
0x00	1	x0	xxxx1x		UNALLOCATED
0x00	1	x0	xxxxx1		UNALLOCATED
1101	0	1x	1xxxxx		Load/store memory tags
1x00	1				UNALLOCATED

xx00	0	0x			Load/store exclusive
xx01	0	1x	0xxxxx	00	LDAPR/STLR (unscaled immediate)
xx01		0x			Load register (literal)
xx10		00			Load/store no-allocate pair (offset)
xx10		01			Load/store register pair (post-indexed)
xx10		10			Load/store register pair (offset)
xx10		11			Load/store register pair (pre-indexed)
xx11		0x	0xxxxx	00	Load/store register (unscaled immediate)
xx11		0x	0xxxxx	01	Load/store register (immediate post-indexed)
xx11		0x	0xxxxx	10	Load/store register (unprivileged)
xx11		0x	0xxxxx	11	Load/store register (immediate pre-indexed)
xx11		0x	1xxxxx	00	Atomic memory operations
xx11		0x	1xxxxx	10	Load/store register (register offset)
xx11		0x	1xxxxx	x1	Load/store register (pac)
xx11		1x			Load/store register (unsigned immediate)

Advanced SIMD load/store multiple structures

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	0	0	1	1	0	0	0	L	0	0	0	0	0	0	opcode				size		Rn					Rt				

Decode fields L	opcode	Instruction Details
0	0000	ST4 (multiple structures)
0	0001	UNALLOCATED
0	0010	ST1 (multiple structures) — four registers
0	0011	UNALLOCATED
0	0100	ST3 (multiple structures)
0	0101	UNALLOCATED
0	0110	ST1 (multiple structures) — three registers
0	0111	ST1 (multiple structures) — one register
0	1000	ST2 (multiple structures)
0	1001	UNALLOCATED
0	1010	ST1 (multiple structures) — two registers
0	1011	UNALLOCATED
0	11xx	UNALLOCATED
1	0000	LD4 (multiple structures)
1	0001	UNALLOCATED
1	0010	LD1 (multiple structures) — four registers
1	0011	UNALLOCATED
1	0100	LD3 (multiple structures)
1	0101	UNALLOCATED
1	0110	LD1 (multiple structures) — three registers
1	0111	LD1 (multiple structures) — one register
1	1000	LD2 (multiple structures)
1	1001	UNALLOCATED
1	1010	LD1 (multiple structures) — two registers
1	1011	UNALLOCATED

Decode fields L	opcode	Instruction Details
1	11xx	UNALLOCATED

Advanced SIMD load/store multiple structures (post-indexed)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	0	0	1	1	0	0	1	L	0	Rm					opcode				size		Rn					Rt				

L	Decode fields Rm	opcode	Instruction Details
0		0001	UNALLOCATED
0		0011	UNALLOCATED
0		0101	UNALLOCATED
0		1001	UNALLOCATED
0		1011	UNALLOCATED
0		11xx	UNALLOCATED
0	!= 11111	0000	ST4 (multiple structures) — register offset
0	!= 11111	0010	ST1 (multiple structures) — four registers, register offset
0	!= 11111	0100	ST3 (multiple structures) — register offset
0	!= 11111	0110	ST1 (multiple structures) — three registers, register offset
0	!= 11111	0111	ST1 (multiple structures) — one register, register offset
0	!= 11111	1000	ST2 (multiple structures) — register offset
0	!= 11111	1010	ST1 (multiple structures) — two registers, register offset
0	11111	0000	ST4 (multiple structures) — immediate offset
0	11111	0010	ST1 (multiple structures) — four registers, immediate offset
0	11111	0100	ST3 (multiple structures) — immediate offset
0	11111	0110	ST1 (multiple structures) — three registers, immediate offset
0	11111	0111	ST1 (multiple structures) — one register, immediate offset
0	11111	1000	ST2 (multiple structures) — immediate offset
0	11111	1010	ST1 (multiple structures) — two registers, immediate offset
1		0001	UNALLOCATED
1		0011	UNALLOCATED
1		0101	UNALLOCATED
1		1001	UNALLOCATED
1		1011	UNALLOCATED
1		11xx	UNALLOCATED
1	!= 11111	0000	LD4 (multiple structures) — register offset
1	!= 11111	0010	LD1 (multiple structures) — four registers, register offset
1	!= 11111	0100	LD3 (multiple structures) — register offset
1	!= 11111	0110	LD1 (multiple structures) — three registers, register offset
1	!= 11111	0111	LD1 (multiple structures) — one register, register offset
1	!= 11111	1000	LD2 (multiple structures) — register offset
1	!= 11111	1010	LD1 (multiple structures) — two registers, register offset
1	11111	0000	LD4 (multiple structures) — immediate offset
1	11111	0010	LD1 (multiple structures) — four registers, immediate offset
1	11111	0100	LD3 (multiple structures) — immediate offset
1	11111	0110	LD1 (multiple structures) — three registers, immediate offset
1	11111	0111	LD1 (multiple structures) — one register, immediate offset

Decode fields			Instruction Details
L	Rm	opcode	
1	11111	1000	LD2 (multiple structures) — immediate offset
1	11111	1010	LD1 (multiple structures) — two registers, immediate offset

Advanced SIMD load/store single structure

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	0	0	1	1	0	1	0	L	R	0	0	0	0	0	opcode			S	size		Rn					Rt				

Decode fields					Instruction Details
L	R	opcode	S	size	
0		11x			UNALLOCATED
0	0	000			ST1 (single structure) — 8-bit
0	0	001			ST3 (single structure) — 8-bit
0	0	010		x0	ST1 (single structure) — 16-bit
0	0	010		x1	UNALLOCATED
0	0	011		x0	ST3 (single structure) — 16-bit
0	0	011		x1	UNALLOCATED
0	0	100		00	ST1 (single structure) — 32-bit
0	0	100		1x	UNALLOCATED
0	0	100	0	01	ST1 (single structure) — 64-bit
0	0	100	1	01	UNALLOCATED
0	0	101		00	ST3 (single structure) — 32-bit
0	0	101		10	UNALLOCATED
0	0	101	0	01	ST3 (single structure) — 64-bit
0	0	101	0	11	UNALLOCATED
0	0	101	1	x1	UNALLOCATED
0	1	000			ST2 (single structure) — 8-bit
0	1	001			ST4 (single structure) — 8-bit
0	1	010		x0	ST2 (single structure) — 16-bit
0	1	010		x1	UNALLOCATED
0	1	011		x0	ST4 (single structure) — 16-bit
0	1	011		x1	UNALLOCATED
0	1	100		00	ST2 (single structure) — 32-bit
0	1	100		10	UNALLOCATED
0	1	100	0	01	ST2 (single structure) — 64-bit
0	1	100	0	11	UNALLOCATED
0	1	100	1	x1	UNALLOCATED
0	1	101		00	ST4 (single structure) — 32-bit
0	1	101		10	UNALLOCATED
0	1	101	0	01	ST4 (single structure) — 64-bit
0	1	101	0	11	UNALLOCATED
0	1	101	1	x1	UNALLOCATED
1	0	000			LD1 (single structure) — 8-bit
1	0	001			LD3 (single structure) — 8-bit
1	0	010		x0	LD1 (single structure) — 16-bit
1	0	010		x1	UNALLOCATED
1	0	011		x0	LD3 (single structure) — 16-bit

Decode fields					Instruction Details
L	R	opcode	S	size	
1	0	011		x1	UNALLOCATED
1	0	100		00	LD1 (single structure) — 32-bit
1	0	100		1x	UNALLOCATED
1	0	100	0	01	LD1 (single structure) — 64-bit
1	0	100	1	01	UNALLOCATED
1	0	101		00	LD3 (single structure) — 32-bit
1	0	101		10	UNALLOCATED
1	0	101	0	01	LD3 (single structure) — 64-bit
1	0	101	0	11	UNALLOCATED
1	0	101	1	x1	UNALLOCATED
1	0	110	0		LD1R
1	0	110	1		UNALLOCATED
1	0	111	0		LD3R
1	0	111	1		UNALLOCATED
1	1	000			LD2 (single structure) — 8-bit
1	1	001			LD4 (single structure) — 8-bit
1	1	010		x0	LD2 (single structure) — 16-bit
1	1	010		x1	UNALLOCATED
1	1	011		x0	LD4 (single structure) — 16-bit
1	1	011		x1	UNALLOCATED
1	1	100		00	LD2 (single structure) — 32-bit
1	1	100		10	UNALLOCATED
1	1	100	0	01	LD2 (single structure) — 64-bit
1	1	100	0	11	UNALLOCATED
1	1	100	1	x1	UNALLOCATED
1	1	101		00	LD4 (single structure) — 32-bit
1	1	101		10	UNALLOCATED
1	1	101	0	01	LD4 (single structure) — 64-bit
1	1	101	0	11	UNALLOCATED
1	1	101	1	x1	UNALLOCATED
1	1	110	0		LD2R
1	1	110	1		UNALLOCATED
1	1	111	0		LD4R
1	1	111	1		UNALLOCATED

Advanced SIMD load/store single structure (post-indexed)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	0	0	1	1	0	1	1	L	R	Rm					opcode			S	size		Rn					Rt				

Decode fields						Instruction Details
L	R	Rm	opcode	S	size	
0			11x			UNALLOCATED
0	0		010		x1	UNALLOCATED
0	0		011		x1	UNALLOCATED
0	0		100		1x	UNALLOCATED
0	0		100	1	01	UNALLOCATED

Decode fields						Instruction Details
L	R	Rm	opcode	S	size	
0	0		101		10	UNALLOCATED
0	0		101	0	11	UNALLOCATED
0	0		101	1	x1	UNALLOCATED
0	0	!= 11111	000			ST1 (single structure) — 8-bit, register offset
0	0	!= 11111	001			ST3 (single structure) — 8-bit, register offset
0	0	!= 11111	010		x0	ST1 (single structure) — 16-bit, register offset
0	0	!= 11111	011		x0	ST3 (single structure) — 16-bit, register offset
0	0	!= 11111	100		00	ST1 (single structure) — 32-bit, register offset
0	0	!= 11111	100	0	01	ST1 (single structure) — 64-bit, register offset
0	0	!= 11111	101		00	ST3 (single structure) — 32-bit, register offset
0	0	!= 11111	101	0	01	ST3 (single structure) — 64-bit, register offset
0	0	11111	000			ST1 (single structure) — 8-bit, immediate offset
0	0	11111	001			ST3 (single structure) — 8-bit, immediate offset
0	0	11111	010		x0	ST1 (single structure) — 16-bit, immediate offset
0	0	11111	011		x0	ST3 (single structure) — 16-bit, immediate offset
0	0	11111	100		00	ST1 (single structure) — 32-bit, immediate offset
0	0	11111	100	0	01	ST1 (single structure) — 64-bit, immediate offset
0	0	11111	101		00	ST3 (single structure) — 32-bit, immediate offset
0	0	11111	101	0	01	ST3 (single structure) — 64-bit, immediate offset
0	1		010		x1	UNALLOCATED
0	1		011		x1	UNALLOCATED
0	1		100		10	UNALLOCATED
0	1		100	0	11	UNALLOCATED
0	1		100	1	x1	UNALLOCATED
0	1		101		10	UNALLOCATED
0	1		101	0	11	UNALLOCATED
0	1		101	1	x1	UNALLOCATED
0	1	!= 11111	000			ST2 (single structure) — 8-bit, register offset
0	1	!= 11111	001			ST4 (single structure) — 8-bit, register offset
0	1	!= 11111	010		x0	ST2 (single structure) — 16-bit, register offset
0	1	!= 11111	011		x0	ST4 (single structure) — 16-bit, register offset
0	1	!= 11111	100		00	ST2 (single structure) — 32-bit, register offset
0	1	!= 11111	100	0	01	ST2 (single structure) — 64-bit, register offset
0	1	!= 11111	101		00	ST4 (single structure) — 32-bit, register offset
0	1	!= 11111	101	0	01	ST4 (single structure) — 64-bit, register offset
0	1	11111	000			ST2 (single structure) — 8-bit, immediate offset
0	1	11111	001			ST4 (single structure) — 8-bit, immediate offset
0	1	11111	010		x0	ST2 (single structure) — 16-bit, immediate offset
0	1	11111	011		x0	ST4 (single structure) — 16-bit, immediate offset
0	1	11111	100		00	ST2 (single structure) — 32-bit, immediate offset
0	1	11111	100	0	01	ST2 (single structure) — 64-bit, immediate offset
0	1	11111	101		00	ST4 (single structure) — 32-bit, immediate offset
0	1	11111	101	0	01	ST4 (single structure) — 64-bit, immediate offset
1	0		010		x1	UNALLOCATED
1	0		011		x1	UNALLOCATED
1	0		100		1x	UNALLOCATED
1	0		100	1	01	UNALLOCATED

Decode fields						Instruction Details
L	R	Rm	opcode	S	size	
1	0		101		10	UNALLOCATED
1	0		101	0	11	UNALLOCATED
1	0		101	1	x1	UNALLOCATED
1	0		110	1		UNALLOCATED
1	0		111	1		UNALLOCATED
1	0	!= 11111	000			LD1 (single structure) — 8-bit, register offset
1	0	!= 11111	001			LD3 (single structure) — 8-bit, register offset
1	0	!= 11111	010		x0	LD1 (single structure) — 16-bit, register offset
1	0	!= 11111	011		x0	LD3 (single structure) — 16-bit, register offset
1	0	!= 11111	100		00	LD1 (single structure) — 32-bit, register offset
1	0	!= 11111	100	0	01	LD1 (single structure) — 64-bit, register offset
1	0	!= 11111	101		00	LD3 (single structure) — 32-bit, register offset
1	0	!= 11111	101	0	01	LD3 (single structure) — 64-bit, register offset
1	0	!= 11111	110	0		LD1R — register offset
1	0	!= 11111	111	0		LD3R — register offset
1	0	11111	000			LD1 (single structure) — 8-bit, immediate offset
1	0	11111	001			LD3 (single structure) — 8-bit, immediate offset
1	0	11111	010		x0	LD1 (single structure) — 16-bit, immediate offset
1	0	11111	011		x0	LD3 (single structure) — 16-bit, immediate offset
1	0	11111	100		00	LD1 (single structure) — 32-bit, immediate offset
1	0	11111	100	0	01	LD1 (single structure) — 64-bit, immediate offset
1	0	11111	101		00	LD3 (single structure) — 32-bit, immediate offset
1	0	11111	101	0	01	LD3 (single structure) — 64-bit, immediate offset
1	0	11111	110	0		LD1R — immediate offset
1	0	11111	111	0		LD3R — immediate offset
1	1		010		x1	UNALLOCATED
1	1		011		x1	UNALLOCATED
1	1		100		10	UNALLOCATED
1	1		100	0	11	UNALLOCATED
1	1		100	1	x1	UNALLOCATED
1	1		101		10	UNALLOCATED
1	1		101	0	11	UNALLOCATED
1	1		101	1	x1	UNALLOCATED
1	1		110	1		UNALLOCATED
1	1		111	1		UNALLOCATED
1	1	!= 11111	000			LD2 (single structure) — 8-bit, register offset
1	1	!= 11111	001			LD4 (single structure) — 8-bit, register offset
1	1	!= 11111	010		x0	LD2 (single structure) — 16-bit, register offset
1	1	!= 11111	011		x0	LD4 (single structure) — 16-bit, register offset
1	1	!= 11111	100		00	LD2 (single structure) — 32-bit, register offset
1	1	!= 11111	100	0	01	LD2 (single structure) — 64-bit, register offset
1	1	!= 11111	101		00	LD4 (single structure) — 32-bit, register offset
1	1	!= 11111	101	0	01	LD4 (single structure) — 64-bit, register offset
1	1	!= 11111	110	0		LD2R — register offset
1	1	!= 11111	111	0		LD4R — register offset
1	1	11111	000			LD2 (single structure) — 8-bit, immediate offset
1	1	11111	001			LD4 (single structure) — 8-bit, immediate offset

Decode fields						Instruction Details
L	R	Rm	opcode	S	size	
1	1	11111	010		x0	LD2 (single structure) — 16-bit, immediate offset
1	1	11111	011		x0	LD4 (single structure) — 16-bit, immediate offset
1	1	11111	100		00	LD2 (single structure) — 32-bit, immediate offset
1	1	11111	100	0	01	LD2 (single structure) — 64-bit, immediate offset
1	1	11111	101		00	LD4 (single structure) — 32-bit, immediate offset
1	1	11111	101	0	01	LD4 (single structure) — 64-bit, immediate offset
1	1	11111	110	0		LD2R — immediate offset
1	1	11111	111	0		LD4R — immediate offset

Load/store memory tags

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	1	0	0	1	opc		1	imm9									op2		Rn					Rt				

opc	Decode fields imm9	op2	Instruction Details	Architecture Version
00		01	STG — post-index	Armv8.5
00		10	STG — signed offset	Armv8.5
00		11	STG — pre-index	Armv8.5
00	000000000	00	STZGM	Armv8.5
01		00	LDG	Armv8.5
01		01	STZG — post-index	Armv8.5
01		10	STZG — signed offset	Armv8.5
01		11	STZG — pre-index	Armv8.5
10		01	ST2G — post-index	Armv8.5
10		10	ST2G — signed offset	Armv8.5
10		11	ST2G — pre-index	Armv8.5
10	!= 000000000	00	UNALLOCATED	-
10	000000000	00	STGM	Armv8.5
11		01	STZ2G — post-index	Armv8.5
11		10	STZ2G — signed offset	Armv8.5
11		11	STZ2G — pre-index	Armv8.5
11	!= 000000000	00	UNALLOCATED	-
11	000000000	00	LDGM	Armv8.5

Load/store exclusive

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
size		0	0	1	0	0	0	o2	L	o1	Rs					o0	Rt2					Rn					Rt				

Decode fields						Instruction Details	Architecture Version
size	o2	L	o1	o0	Rt2		
	1		1		!= 11111	UNALLOCATED	-
0x	0		1		!= 11111	UNALLOCATED	-
00	0	0	0	0		STXRB	-
00	0	0	0	1		STLXRB	-

Decode fields						Instruction Details	Architecture Version
size	o2	L	o1	o0	Rt2		
00	0	0	1	0	11111	CASP, CASPA, CASPAL, CASPL — 32-bit CASP	Armv8.1
00	0	0	1	1	11111	CASP, CASPA, CASPAL, CASPL — 32-bit CASPL	Armv8.1
00	0	1	0	0		LDXRB	-
00	0	1	0	1		LDAXRB	-
00	0	1	1	0	11111	CASP, CASPA, CASPAL, CASPL — 32-bit CASPA	Armv8.1
00	0	1	1	1	11111	CASP, CASPA, CASPAL, CASPL — 32-bit CASPAL	Armv8.1
00	1	0	0	0		STLLRB	Armv8.1
00	1	0	0	1		STLRB	-
00	1	0	1	0	11111	CASB, CASAB, CASALB, CASLB — CASB	Armv8.1
00	1	0	1	1	11111	CASB, CASAB, CASALB, CASLB — CASLB	Armv8.1
00	1	1	0	0		LDLARB	Armv8.1
00	1	1	0	1		LDARB	-
00	1	1	1	0	11111	CASB, CASAB, CASALB, CASLB — CASAB	Armv8.1
00	1	1	1	1	11111	CASB, CASAB, CASALB, CASLB — CASALB	Armv8.1
01	0	0	0	0		STXRH	-
01	0	0	0	1		STLXRH	-
01	0	0	1	0	11111	CASP, CASPA, CASPAL, CASPL — 64-bit CASP	Armv8.1
01	0	0	1	1	11111	CASP, CASPA, CASPAL, CASPL — 64-bit CASPL	Armv8.1
01	0	1	0	0		LDXRH	-
01	0	1	0	1		LDAXRH	-
01	0	1	1	0	11111	CASP, CASPA, CASPAL, CASPL — 64-bit CASPA	Armv8.1
01	0	1	1	1	11111	CASP, CASPA, CASPAL, CASPL — 64-bit CASPAL	Armv8.1
01	1	0	0	0		STLLRH	Armv8.1
01	1	0	0	1		STLRH	-
01	1	0	1	0	11111	CASH, CASAH, CASALH, CASLH — CASH	Armv8.1
01	1	0	1	1	11111	CASH, CASAH, CASALH, CASLH — CASLH	Armv8.1
01	1	1	0	0		LDLARH	Armv8.1
01	1	1	0	1		LDARH	-
01	1	1	1	0	11111	CASH, CASAH, CASALH, CASLH — CASAH	Armv8.1
01	1	1	1	1	11111	CASH, CASAH, CASALH, CASLH — CASALH	Armv8.1
10	0	0	0	0		STXR — 32-bit	-
10	0	0	0	1		STLXR — 32-bit	-
10	0	0	1	0		STXP — 32-bit	-
10	0	0	1	1		STLXP — 32-bit	-
10	0	1	0	0		LDXR — 32-bit	-
10	0	1	0	1		LDAXR — 32-bit	-
10	0	1	1	0		LDXP — 32-bit	-
10	0	1	1	1		LDAXP — 32-bit	-
10	1	0	0	0		STLLR — 32-bit	Armv8.1
10	1	0	0	1		STLR — 32-bit	-
10	1	0	1	0	11111	CAS, CASA, CASAL, CASL — 32-bit CAS	Armv8.1
10	1	0	1	1	11111	CAS, CASA, CASAL, CASL — 32-bit CASL	Armv8.1
10	1	1	0	0		LDLAR — 32-bit	Armv8.1
10	1	1	0	1		LDAR — 32-bit	-
10	1	1	1	0	11111	CAS, CASA, CASAL, CASL — 32-bit CASA	Armv8.1
10	1	1	1	1	11111	CAS, CASA, CASAL, CASL — 32-bit CASAL	Armv8.1
11	0	0	0	0		STXR — 64-bit	-

Decode fields						Instruction Details	Architecture Version
size	o2	L	o1	o0	Rt2		
11	0	0	0	1		STLXR — 64-bit	-
11	0	0	1	0		STXP — 64-bit	-
11	0	0	1	1		STLXP — 64-bit	-
11	0	1	0	0		LDXR — 64-bit	-
11	0	1	0	1		LDAXR — 64-bit	-
11	0	1	1	0		LDXP — 64-bit	-
11	0	1	1	1		LDAXP — 64-bit	-
11	1	0	0	0		STLLR — 64-bit	Armv8.1
11	1	0	0	1		STLR — 64-bit	-
11	1	0	1	0	11111	CAS, CASA, CASAL, CASL — 64-bit CAS	Armv8.1
11	1	0	1	1	11111	CAS, CASA, CASAL, CASL — 64-bit CASL	Armv8.1
11	1	1	0	0		LDLAR — 64-bit	Armv8.1
11	1	1	0	1		LDAR — 64-bit	-
11	1	1	1	0	11111	CAS, CASA, CASAL, CASL — 64-bit CASA	Armv8.1
11	1	1	1	1	11111	CAS, CASA, CASAL, CASL — 64-bit CASAL	Armv8.1

LDAPR/STLR (unscaled immediate)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
size		0	1	1	0	0	1	opc		0	imm9									0	0	Rn					Rt				

Decode fields		Instruction Details	Architecture Version
size	opc		
00	00	STLURB	Armv8.4
00	01	LDAPURB	Armv8.4
00	10	LDAPURSB — 64-bit	Armv8.4
00	11	LDAPURSB — 32-bit	Armv8.4
01	00	STLURH	Armv8.4
01	01	LDAPURH	Armv8.4
01	10	LDAPURSH — 64-bit	Armv8.4
01	11	LDAPURSH — 32-bit	Armv8.4
10	00	STLUR — 32-bit	Armv8.4
10	01	LDAPUR — 32-bit	Armv8.4
10	10	LDAPURSW	Armv8.4
10	11	UNALLOCATED	-
11	00	STLUR — 64-bit	Armv8.4
11	01	LDAPUR — 64-bit	Armv8.4
11	10	UNALLOCATED	-
11	11	UNALLOCATED	-

Load register (literal)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
opc		0	1	1	V	0	0	imm19																			Rt				

Decode fields opc	V	Instruction Details
00	0	LDR (literal) — 32-bit
00	1	LDR (literal, SIMD&FP) — 32-bit
01	0	LDR (literal) — 64-bit
01	1	LDR (literal, SIMD&FP) — 64-bit
10	0	LDRSW (literal)
10	1	LDR (literal, SIMD&FP) — 128-bit
11	0	PRFM (literal)
11	1	UNALLOCATED

Load/store no-allocate pair (offset)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
opc		1	0	1	V	0	0	0	L	imm7							Rt2					Rn					Rt				

Decode fields opc	V	L	Instruction Details
00	0	0	STNP — 32-bit
00	0	1	LDNP — 32-bit
00	1	0	STNP (SIMD&FP) — 32-bit
00	1	1	LDNP (SIMD&FP) — 32-bit
01	0		UNALLOCATED
01	1	0	STNP (SIMD&FP) — 64-bit
01	1	1	LDNP (SIMD&FP) — 64-bit
10	0	0	STNP — 64-bit
10	0	1	LDNP — 64-bit
10	1	0	STNP (SIMD&FP) — 128-bit
10	1	1	LDNP (SIMD&FP) — 128-bit
11			UNALLOCATED

Load/store register pair (post-indexed)

These instructions are under Loads and Stores.

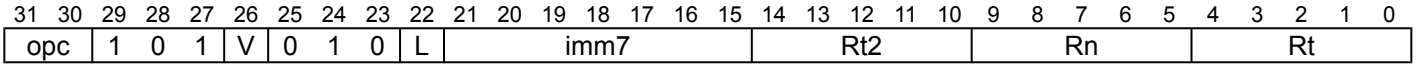
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
opc		1	0	1	V	0	0	1	L	imm7							Rt2					Rn					Rt				

Decode fields opc	V	L	Instruction Details	Architecture Version
00	0	0	STP — 32-bit	-
00	0	1	LDP — 32-bit	-
00	1	0	STP (SIMD&FP) — 32-bit	-
00	1	1	LDP (SIMD&FP) — 32-bit	-
01	0	0	STGP	Armv8.5
01	0	1	LDPSW	-
01	1	0	STP (SIMD&FP) — 64-bit	-
01	1	1	LDP (SIMD&FP) — 64-bit	-
10	0	0	STP — 64-bit	-
10	0	1	LDP — 64-bit	-

Decode fields opc	V	L	Instruction Details	Architecture Version
10	1	0	STP (SIMD&FP) — 128-bit	-
10	1	1	LDP (SIMD&FP) — 128-bit	-
11			UNALLOCATED	-

Load/store register pair (offset)

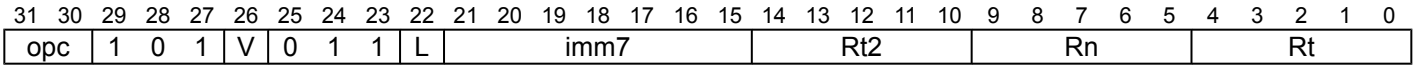
These instructions are under Loads and Stores.



Decode fields opc	V	L	Instruction Details	Architecture Version
00	0	0	STP — 32-bit	-
00	0	1	LDP — 32-bit	-
00	1	0	STP (SIMD&FP) — 32-bit	-
00	1	1	LDP (SIMD&FP) — 32-bit	-
01	0	0	STGP	Armv8.5
01	0	1	LDPSW	-
01	1	0	STP (SIMD&FP) — 64-bit	-
01	1	1	LDP (SIMD&FP) — 64-bit	-
10	0	0	STP — 64-bit	-
10	0	1	LDP — 64-bit	-
10	1	0	STP (SIMD&FP) — 128-bit	-
10	1	1	LDP (SIMD&FP) — 128-bit	-
11			UNALLOCATED	-

Load/store register pair (pre-indexed)

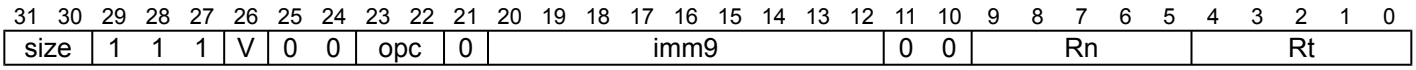
These instructions are under Loads and Stores.



Decode fields opc	V	L	Instruction Details	Architecture Version
00	0	0	STP — 32-bit	-
00	0	1	LDP — 32-bit	-
00	1	0	STP (SIMD&FP) — 32-bit	-
00	1	1	LDP (SIMD&FP) — 32-bit	-
01	0	0	STGP	Armv8.5
01	0	1	LDPSW	-
01	1	0	STP (SIMD&FP) — 64-bit	-
01	1	1	LDP (SIMD&FP) — 64-bit	-
10	0	0	STP — 64-bit	-
10	0	1	LDP — 64-bit	-
10	1	0	STP (SIMD&FP) — 128-bit	-
10	1	1	LDP (SIMD&FP) — 128-bit	-
11			UNALLOCATED	-

Load/store register (unscaled immediate)

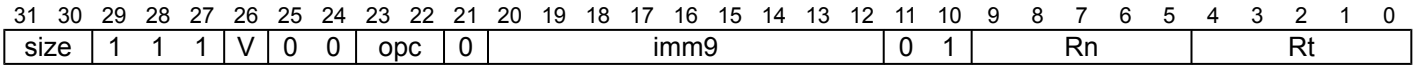
These instructions are under Loads and Stores.



Decode fields size	V	opc	Instruction Details
x1	1	1x	UNALLOCATED
00	0	00	STURB
00	0	01	LDURB
00	0	10	LDURSB — 64-bit
00	0	11	LDURSB — 32-bit
00	1	00	STUR (SIMD&FP) — 8-bit
00	1	01	LDUR (SIMD&FP) — 8-bit
00	1	10	STUR (SIMD&FP) — 128-bit
00	1	11	LDUR (SIMD&FP) — 128-bit
01	0	00	STURH
01	0	01	LDURH
01	0	10	LDURSH — 64-bit
01	0	11	LDURSH — 32-bit
01	1	00	STUR (SIMD&FP) — 16-bit
01	1	01	LDUR (SIMD&FP) — 16-bit
1x	0	11	UNALLOCATED
1x	1	1x	UNALLOCATED
10	0	00	STUR — 32-bit
10	0	01	LDUR — 32-bit
10	0	10	LDURSW
10	1	00	STUR (SIMD&FP) — 32-bit
10	1	01	LDUR (SIMD&FP) — 32-bit
11	0	00	STUR — 64-bit
11	0	01	LDUR — 64-bit
11	0	10	PRFUM
11	1	00	STUR (SIMD&FP) — 64-bit
11	1	01	LDUR (SIMD&FP) — 64-bit

Load/store register (immediate post-indexed)

These instructions are under Loads and Stores.

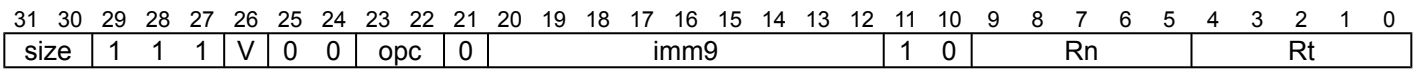


Decode fields size	V	opc	Instruction Details
x1	1	1x	UNALLOCATED
00	0	00	STRB (immediate)
00	0	01	LDRB (immediate)
00	0	10	LDRSB (immediate) — 64-bit
00	0	11	LDRSB (immediate) — 32-bit
00	1	00	STR (immediate, SIMD&FP) — 8-bit
00	1	01	LDR (immediate, SIMD&FP) — 8-bit

Decode fields size	V	opc	Instruction Details
00	1	10	STR (immediate, SIMD&FP) — 128-bit
00	1	11	LDR (immediate, SIMD&FP) — 128-bit
01	0	00	STRH (immediate)
01	0	01	LDRH (immediate)
01	0	10	LDRSH (immediate) — 64-bit
01	0	11	LDRSH (immediate) — 32-bit
01	1	00	STR (immediate, SIMD&FP) — 16-bit
01	1	01	LDR (immediate, SIMD&FP) — 16-bit
1x	0	11	UNALLOCATED
1x	1	1x	UNALLOCATED
10	0	00	STR (immediate) — 32-bit
10	0	01	LDR (immediate) — 32-bit
10	0	10	LDRSW (immediate)
10	1	00	STR (immediate, SIMD&FP) — 32-bit
10	1	01	LDR (immediate, SIMD&FP) — 32-bit
11	0	00	STR (immediate) — 64-bit
11	0	01	LDR (immediate) — 64-bit
11	0	10	UNALLOCATED
11	1	00	STR (immediate, SIMD&FP) — 64-bit
11	1	01	LDR (immediate, SIMD&FP) — 64-bit

Load/store register (unprivileged)

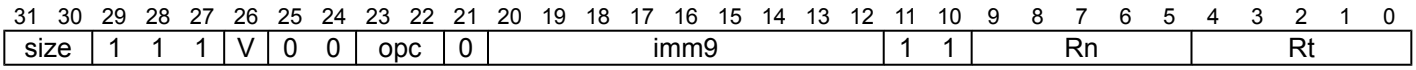
These instructions are under Loads and Stores.



Decode fields size	V	opc	Instruction Details
	1		UNALLOCATED
00	0	00	STTRB
00	0	01	LDTRB
00	0	10	LDTRSB — 64-bit
00	0	11	LDTRSB — 32-bit
01	0	00	STTRH
01	0	01	LDTRH
01	0	10	LDTRSH — 64-bit
01	0	11	LDTRSH — 32-bit
1x	0	11	UNALLOCATED
10	0	00	STTR — 32-bit
10	0	01	LDTR — 32-bit
10	0	10	LDTRSW
11	0	00	STTR — 64-bit
11	0	01	LDTR — 64-bit
11	0	10	UNALLOCATED

Load/store register (immediate pre-indexed)

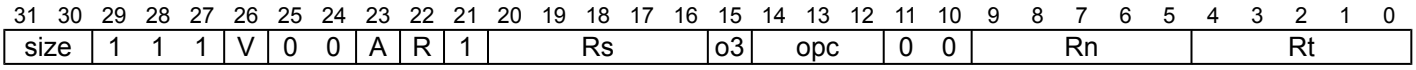
These instructions are under Loads and Stores.



Decode fields			Instruction Details
size	V	opc	
x1	1	1x	UNALLOCATED
00	0	00	STRB (immediate)
00	0	01	LDRB (immediate)
00	0	10	LDRSB (immediate) — 64-bit
00	0	11	LDRSB (immediate) — 32-bit
00	1	00	STR (immediate, SIMD&FP) — 8-bit
00	1	01	LDR (immediate, SIMD&FP) — 8-bit
00	1	10	STR (immediate, SIMD&FP) — 128-bit
00	1	11	LDR (immediate, SIMD&FP) — 128-bit
01	0	00	STRH (immediate)
01	0	01	LDRH (immediate)
01	0	10	LDRSH (immediate) — 64-bit
01	0	11	LDRSH (immediate) — 32-bit
01	1	00	STR (immediate, SIMD&FP) — 16-bit
01	1	01	LDR (immediate, SIMD&FP) — 16-bit
1x	0	11	UNALLOCATED
1x	1	1x	UNALLOCATED
10	0	00	STR (immediate) — 32-bit
10	0	01	LDR (immediate) — 32-bit
10	0	10	LDRSW (immediate)
10	1	00	STR (immediate, SIMD&FP) — 32-bit
10	1	01	LDR (immediate, SIMD&FP) — 32-bit
11	0	00	STR (immediate) — 64-bit
11	0	01	LDR (immediate) — 64-bit
11	0	10	UNALLOCATED
11	1	00	STR (immediate, SIMD&FP) — 64-bit
11	1	01	LDR (immediate, SIMD&FP) — 64-bit

Atomic memory operations

These instructions are under Loads and Stores.



Decode fields						Instruction Details	Architecture Version
size	V	A	R	o3	opc		
	0			1	001	UNALLOCATED	-
	0			1	01x	UNALLOCATED	-
	0			1	101	UNALLOCATED	-
	0			1	11x	UNALLOCATED	-
	0	0		1	100	UNALLOCATED	-
	0	1	1	1	100	UNALLOCATED	-
	1					UNALLOCATED	-

Decode fields						Instruction Details	Architecture Version
size	V	A	R	o3	opc		
00	0	0	0	0	000	LDADDB, LDADDAB, LDADDALB, LDADDLB — LDADDB	Armv8.1
00	0	0	0	0	001	LDCLRB, LDCLRAB, LDCLRALB, LDCLRLB — LDCLRB	Armv8.1
00	0	0	0	0	010	LDEORB, LDEORAB, LDEORALB, LDEORLB — LDEORB	Armv8.1
00	0	0	0	0	011	LDSETB, LDSETAB, LDSETALB, LDSETLB — LDSETB	Armv8.1
00	0	0	0	0	100	LDSMAXB, LDSMAXAB, LDSMAXALB, LDSMAXLB — LDSMAXB	Armv8.1
00	0	0	0	0	101	LDSMINB, LDSMINAB, LDSMINALB, LDSMINLB — LDSMINB	Armv8.1
00	0	0	0	0	110	LDUMAXB, LDUMAXAB, LDUMAXALB, LDUMAXLB — LDUMAXB	Armv8.1
00	0	0	0	0	111	LDUMINB, LDUMINAB, LDUMINALB, LDUMINLB — LDUMINB	Armv8.1
00	0	0	0	1	000	SWPB, SWPAB, SWPALB, SWPLB — SWPB	Armv8.1
00	0	0	1	0	000	LDADDB, LDADDAB, LDADDALB, LDADDLB — LDADDLB	Armv8.1
00	0	0	1	0	001	LDCLRB, LDCLRAB, LDCLRALB, LDCLRLB — LDCLRLB	Armv8.1
00	0	0	1	0	010	LDEORB, LDEORAB, LDEORALB, LDEORLB — LDEORLB	Armv8.1
00	0	0	1	0	011	LDSETB, LDSETAB, LDSETALB, LDSETLB — LDSETLB	Armv8.1
00	0	0	1	0	100	LDSMAXB, LDSMAXAB, LDSMAXALB, LDSMAXLB — LDSMAXLB	Armv8.1
00	0	0	1	0	101	LDSMINB, LDSMINAB, LDSMINALB, LDSMINLB — LDSMINLB	Armv8.1
00	0	0	1	0	110	LDUMAXB, LDUMAXAB, LDUMAXALB, LDUMAXLB — LDUMAXLB	Armv8.1
00	0	0	1	0	111	LDUMINB, LDUMINAB, LDUMINALB, LDUMINLB — LDUMINLB	Armv8.1
00	0	0	1	1	000	SWPB, SWPAB, SWPALB, SWPLB — SWPLB	Armv8.1
00	0	1	0	0	000	LDADDB, LDADDAB, LDADDALB, LDADDLB — LDADDAB	Armv8.1
00	0	1	0	0	001	LDCLRB, LDCLRAB, LDCLRALB, LDCLRLB — LDCLRAB	Armv8.1
00	0	1	0	0	010	LDEORB, LDEORAB, LDEORALB, LDEORLB — LDEORAB	Armv8.1
00	0	1	0	0	011	LDSETB, LDSETAB, LDSETALB, LDSETLB — LDSETAB	Armv8.1
00	0	1	0	0	100	LDSMAXB, LDSMAXAB, LDSMAXALB, LDSMAXLB — LDSMAXAB	Armv8.1
00	0	1	0	0	101	LDSMINB, LDSMINAB, LDSMINALB, LDSMINLB — LDSMINAB	Armv8.1
00	0	1	0	0	110	LDUMAXB, LDUMAXAB, LDUMAXALB, LDUMAXLB — LDUMAXAB	Armv8.1
00	0	1	0	0	111	LDUMINB, LDUMINAB, LDUMINALB, LDUMINLB — LDUMINAB	Armv8.1
00	0	1	0	1	000	SWPB, SWPAB, SWPALB, SWPLB — SWPAB	Armv8.1
00	0	1	0	1	100	LDAPRB	Armv8.3
00	0	1	1	0	000	LDADDB, LDADDAB, LDADDALB, LDADDLB — LDADDALB	Armv8.1
00	0	1	1	0	001	LDCLRB, LDCLRAB, LDCLRALB, LDCLRLB — LDCLRALB	Armv8.1
00	0	1	1	0	010	LDEORB, LDEORAB, LDEORALB, LDEORLB — LDEORALB	Armv8.1
00	0	1	1	0	011	LDSETB, LDSETAB, LDSETALB, LDSETLB — LDSETALB	Armv8.1
00	0	1	1	0	100	LDSMAXB, LDSMAXAB, LDSMAXALB, LDSMAXLB — LDSMAXALB	Armv8.1
00	0	1	1	0	101	LDSMINB, LDSMINAB, LDSMINALB, LDSMINLB — LDSMINALB	Armv8.1
00	0	1	1	0	110	LDUMAXB, LDUMAXAB, LDUMAXALB, LDUMAXLB — LDUMAXALB	Armv8.1
00	0	1	1	0	111	LDUMINB, LDUMINAB, LDUMINALB, LDUMINLB — LDUMINALB	Armv8.1
00	0	1	1	1	000	SWPB, SWPAB, SWPALB, SWPLB — SWPALB	Armv8.1
01	0	0	0	0	000	LDADDH, LDADDAH, LDADDALH, LDADDLH — LDADDH	Armv8.1
01	0	0	0	0	001	LDCLRH, LDCLRAH, LDCLRALH, LDCLRLH — LDCLRH	Armv8.1
01	0	0	0	0	010	LDEORH, LDEORAH, LDEORALH, LDEORLH — LDEORH	Armv8.1
01	0	0	0	0	011	LDSETH, LDSETAH, LDSETALH, LDSETLH — LDSETH	Armv8.1

Decode fields						Instruction Details	Architecture Version
size	V	A	R	o3	opc		
01	0	0	0	0	100	LDSMAXH, LDSMAXAH, LDSMAXALH, LDSMAXLH — LDSMAXH	Armv8.1
01	0	0	0	0	101	LDSMINH, LDSMINAH, LDSMINALH, LDSMINLH — LDSMINH	Armv8.1
01	0	0	0	0	110	LDUMAXH, LDUMAXAH, LDUMAXALH, LDUMAXLH — LDUMAXH	Armv8.1
01	0	0	0	0	111	LDUMINH, LDUMINAH, LDUMINALH, LDUMINLH — LDUMINH	Armv8.1
01	0	0	0	1	000	SWPH, SWPAH, SWPALH, SWPLH — SWPH	Armv8.1
01	0	0	1	0	000	LDADDH, LDADDAH, LDADDALH, LDADDLH — LDADDLH	Armv8.1
01	0	0	1	0	001	LDCLRH, LDCLRAH, LDCLRALH, LDCLRLH — LDCLRLH	Armv8.1
01	0	0	1	0	010	LDEORH, LDEORAH, LDEORALH, LDEORLH — LDEORLH	Armv8.1
01	0	0	1	0	011	LDSETH, LDSETAH, LDSETALH, LDSETLH — LDSETLH	Armv8.1
01	0	0	1	0	100	LDSMAXH, LDSMAXAH, LDSMAXALH, LDSMAXLH — LDSMAXLH	Armv8.1
01	0	0	1	0	101	LDSMINH, LDSMINAH, LDSMINALH, LDSMINLH — LDSMINLH	Armv8.1
01	0	0	1	0	110	LDUMAXH, LDUMAXAH, LDUMAXALH, LDUMAXLH — LDUMAXLH	Armv8.1
01	0	0	1	0	111	LDUMINH, LDUMINAH, LDUMINALH, LDUMINLH — LDUMINLH	Armv8.1
01	0	0	1	1	000	SWPH, SWPAH, SWPALH, SWPLH — SWPLH	Armv8.1
01	0	1	0	0	000	LDADDH, LDADDAH, LDADDALH, LDADDLH — LDADDAH	Armv8.1
01	0	1	0	0	001	LDCLRH, LDCLRAH, LDCLRALH, LDCLRLH — LDCLRAH	Armv8.1
01	0	1	0	0	010	LDEORH, LDEORAH, LDEORALH, LDEORLH — LDEORAH	Armv8.1
01	0	1	0	0	011	LDSETH, LDSETAH, LDSETALH, LDSETLH — LDSETAH	Armv8.1
01	0	1	0	0	100	LDSMAXH, LDSMAXAH, LDSMAXALH, LDSMAXLH — LDSMAXAH	Armv8.1
01	0	1	0	0	101	LDSMINH, LDSMINAH, LDSMINALH, LDSMINLH — LDSMINAH	Armv8.1
01	0	1	0	0	110	LDUMAXH, LDUMAXAH, LDUMAXALH, LDUMAXLH — LDUMAXAH	Armv8.1
01	0	1	0	0	111	LDUMINH, LDUMINAH, LDUMINALH, LDUMINLH — LDUMINAH	Armv8.1
01	0	1	0	1	000	SWPH, SWPAH, SWPALH, SWPLH — SWPAH	Armv8.1
01	0	1	0	1	100	LDAPRH	Armv8.3
01	0	1	1	0	000	LDADDH, LDADDAH, LDADDALH, LDADDLH — LDADDALH	Armv8.1
01	0	1	1	0	001	LDCLRH, LDCLRAH, LDCLRALH, LDCLRLH — LDCLRALH	Armv8.1
01	0	1	1	0	010	LDEORH, LDEORAH, LDEORALH, LDEORLH — LDEORALH	Armv8.1
01	0	1	1	0	011	LDSETH, LDSETAH, LDSETALH, LDSETLH — LDSETALH	Armv8.1
01	0	1	1	0	100	LDSMAXH, LDSMAXAH, LDSMAXALH, LDSMAXLH — LDSMAXALH	Armv8.1
01	0	1	1	0	101	LDSMINH, LDSMINAH, LDSMINALH, LDSMINLH — LDSMINALH	Armv8.1
01	0	1	1	0	110	LDUMAXH, LDUMAXAH, LDUMAXALH, LDUMAXLH — LDUMAXALH	Armv8.1
01	0	1	1	0	111	LDUMINH, LDUMINAH, LDUMINALH, LDUMINLH — LDUMINALH	Armv8.1
01	0	1	1	1	000	SWPH, SWPAH, SWPALH, SWPLH — SWPALH	Armv8.1
10	0	0	0	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 32-bit LDADD	Armv8.1
10	0	0	0	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 32-bit LDCLR	Armv8.1
10	0	0	0	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 32-bit LDEOR	Armv8.1
10	0	0	0	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 32-bit LDSET	Armv8.1
10	0	0	0	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 32-bit LDSMAX	Armv8.1
10	0	0	0	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 32-bit LDSMIN	Armv8.1
10	0	0	0	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 32-bit LDUMAX	Armv8.1

Decode fields						Instruction Details	Architecture Version
size	V	A	R	o3	opc		
10	0	0	0	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 32-bit LDUMIN	Armv8.1
10	0	0	0	1	000	SWP, SWPA, SWPAL, SWPL — 32-bit SWP	Armv8.1
10	0	0	1	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 32-bit LDADDL	Armv8.1
10	0	0	1	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 32-bit LDCLRL	Armv8.1
10	0	0	1	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 32-bit LDEORL	Armv8.1
10	0	0	1	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 32-bit LDSETL	Armv8.1
10	0	0	1	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 32-bit LDSMAXL	Armv8.1
10	0	0	1	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 32-bit LDSMINL	Armv8.1
10	0	0	1	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 32-bit LDUMAXL	Armv8.1
10	0	0	1	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 32-bit LDUMINL	Armv8.1
10	0	0	1	1	000	SWP, SWPA, SWPAL, SWPL — 32-bit SWPL	Armv8.1
10	0	1	0	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 32-bit LDADDA	Armv8.1
10	0	1	0	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 32-bit LDCLRA	Armv8.1
10	0	1	0	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 32-bit LDEORA	Armv8.1
10	0	1	0	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 32-bit LDSETA	Armv8.1
10	0	1	0	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 32-bit LDSMAXA	Armv8.1
10	0	1	0	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 32-bit LDSMINA	Armv8.1
10	0	1	0	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 32-bit LDUMAXA	Armv8.1
10	0	1	0	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 32-bit LDUMINA	Armv8.1
10	0	1	0	1	000	SWP, SWPA, SWPAL, SWPL — 32-bit SWPA	Armv8.1
10	0	1	0	1	100	LDAPR — 32-bit	Armv8.3
10	0	1	1	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 32-bit LDADDAL	Armv8.1
10	0	1	1	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 32-bit LDCLRAL	Armv8.1
10	0	1	1	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 32-bit LDEORAL	Armv8.1
10	0	1	1	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 32-bit LDSETAL	Armv8.1
10	0	1	1	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 32-bit LDSMAXAL	Armv8.1
10	0	1	1	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 32-bit LDSMINAL	Armv8.1
10	0	1	1	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 32-bit LDUMAXAL	Armv8.1
10	0	1	1	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 32-bit LDUMINAL	Armv8.1
10	0	1	1	1	000	SWP, SWPA, SWPAL, SWPL — 32-bit SWPAL	Armv8.1
11	0	0	0	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 64-bit LDADD	Armv8.1
11	0	0	0	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 64-bit LDCLR	Armv8.1
11	0	0	0	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 64-bit LDEOR	Armv8.1
11	0	0	0	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 64-bit LDSET	Armv8.1
11	0	0	0	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 64-bit LDSMAX	Armv8.1
11	0	0	0	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 64-bit LDSMIN	Armv8.1
11	0	0	0	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 64-bit LDUMAX	Armv8.1
11	0	0	0	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 64-bit LDUMIN	Armv8.1
11	0	0	0	1	000	SWP, SWPA, SWPAL, SWPL — 64-bit SWP	Armv8.1
11	0	0	1	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 64-bit LDADDL	Armv8.1
11	0	0	1	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 64-bit LDCLRL	Armv8.1
11	0	0	1	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 64-bit LDEORL	Armv8.1
11	0	0	1	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 64-bit LDSETL	Armv8.1

Decode fields						Instruction Details	Architecture Version
size	V	A	R	o3	opc		
11	0	0	1	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 64-bit LDSMAXL	Armv8.1
11	0	0	1	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 64-bit LDSMINL	Armv8.1
11	0	0	1	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 64-bit LDUMAXL	Armv8.1
11	0	0	1	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 64-bit LDUMINL	Armv8.1
11	0	0	1	1	000	SWP, SWPA, SWPAL, SWPL — 64-bit SWPL	Armv8.1
11	0	1	0	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 64-bit LDADDA	Armv8.1
11	0	1	0	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 64-bit LDCLRA	Armv8.1
11	0	1	0	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 64-bit LDEORA	Armv8.1
11	0	1	0	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 64-bit LDSETA	Armv8.1
11	0	1	0	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 64-bit LDSMAXA	Armv8.1
11	0	1	0	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 64-bit LDSMINA	Armv8.1
11	0	1	0	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 64-bit LDUMAXA	Armv8.1
11	0	1	0	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 64-bit LDUMINA	Armv8.1
11	0	1	0	1	000	SWP, SWPA, SWPAL, SWPL — 64-bit SWPA	Armv8.1
11	0	1	0	1	100	LDAPR — 64-bit	Armv8.3
11	0	1	1	0	000	LDADD, LDADDA, LDADDAL, LDADDL — 64-bit LDADDAL	Armv8.1
11	0	1	1	0	001	LDCLR, LDCLRA, LDCLRAL, LDCLRL — 64-bit LDCLRAL	Armv8.1
11	0	1	1	0	010	LDEOR, LDEORA, LDEORAL, LDEORL — 64-bit LDEORAL	Armv8.1
11	0	1	1	0	011	LDSET, LDSETA, LDSETAL, LDSETL — 64-bit LDSETAL	Armv8.1
11	0	1	1	0	100	LDSMAX, LDSMAXA, LDSMAXAL, LDSMAXL — 64-bit LDSMAXAL	Armv8.1
11	0	1	1	0	101	LDSMIN, LDSMINA, LDSMINAL, LDSMINL — 64-bit LDSMINAL	Armv8.1
11	0	1	1	0	110	LDUMAX, LDUMAXA, LDUMAXAL, LDUMAXL — 64-bit LDUMAXAL	Armv8.1
11	0	1	1	0	111	LDUMIN, LDUMINA, LDUMINAL, LDUMINL — 64-bit LDUMINAL	Armv8.1
11	0	1	1	1	000	SWP, SWPA, SWPAL, SWPL — 64-bit SWPAL	Armv8.1

Load/store register (register offset)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
size		1		1	V	0		opc		1	Rm					option			S	1		Rn					Rt				

Decode fields				Instruction Details
size	V	opc	option	
			x0x	UNALLOCATED
x1	1	1x		UNALLOCATED
00	0	00	!= 011	STRB (register) — extended register
00	0	00	011	STRB (register) — shifted register
00	0	01	!= 011	LDRB (register) — extended register
00	0	01	011	LDRB (register) — shifted register
00	0	10	!= 011	LDRSB (register) — 64-bit with extended register offset
00	0	10	011	LDRSB (register) — 64-bit with shifted register offset
00	0	11	!= 011	LDRSB (register) — 32-bit with extended register offset
00	0	11	011	LDRSB (register) — 32-bit with shifted register offset
00	1	00	!= 011	STR (register, SIMD&FP)

Decode fields				Instruction Details
size	V	opc	option	
00	1	00	011	STR (register, SIMD&FP)
00	1	01	!= 011	LDR (register, SIMD&FP)
00	1	01	011	LDR (register, SIMD&FP)
00	1	10		STR (register, SIMD&FP)
00	1	11		LDR (register, SIMD&FP)
01	0	00		STRH (register)
01	0	01		LDRH (register)
01	0	10		LDRSH (register) — 64-bit
01	0	11		LDRSH (register) — 32-bit
01	1	00		STR (register, SIMD&FP)
01	1	01		LDR (register, SIMD&FP)
1x	0	11		UNALLOCATED
1x	1	1x		UNALLOCATED
10	0	00		STR (register) — 32-bit
10	0	01		LDR (register) — 32-bit
10	0	10		LDRSW (register)
10	1	00		STR (register, SIMD&FP)
10	1	01		LDR (register, SIMD&FP)
11	0	00		STR (register) — 64-bit
11	0	01		LDR (register) — 64-bit
11	0	10		PRFM (register)
11	1	00		STR (register, SIMD&FP)
11	1	01		LDR (register, SIMD&FP)

Load/store register (pac)

These instructions are under Loads and Stores.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
size		1		1	V	0		0	M	S	1	imm9								W	1	Rn					Rt				

Decode fields				Instruction Details	Architecture Version
size	V	M	W		
!= 11				UNALLOCATED	-
11	0	0	0	LDRAA, LDRAB — key A, offset	Armv8.3
11	0	0	1	LDRAA, LDRAB — key A, pre-indexed	Armv8.3
11	0	1	0	LDRAA, LDRAB — key B, offset	Armv8.3
11	0	1	1	LDRAA, LDRAB — key B, pre-indexed	Armv8.3
11	1			UNALLOCATED	-

Load/store register (unsigned immediate)

These instructions are under Loads and Stores.

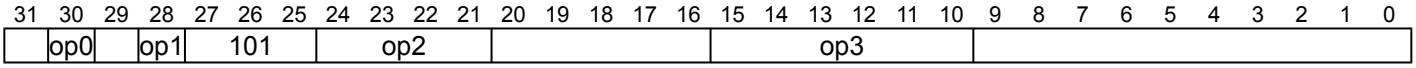
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
size		1		1	V	0		1	opc		imm12											Rn					Rt				

Decode fields			Instruction Details
size	V	opc	
x1	1	1x	UNALLOCATED

Decode fields			Instruction Details
size	V	opc	
00	0	00	STRB (immediate)
00	0	01	LDRB (immediate)
00	0	10	LDRSB (immediate) — 64-bit
00	0	11	LDRSB (immediate) — 32-bit
00	1	00	STR (immediate, SIMD&FP) — 8-bit
00	1	01	LDR (immediate, SIMD&FP) — 8-bit
00	1	10	STR (immediate, SIMD&FP) — 128-bit
00	1	11	LDR (immediate, SIMD&FP) — 128-bit
01	0	00	STRH (immediate)
01	0	01	LDRH (immediate)
01	0	10	LDRSH (immediate) — 64-bit
01	0	11	LDRSH (immediate) — 32-bit
01	1	00	STR (immediate, SIMD&FP) — 16-bit
01	1	01	LDR (immediate, SIMD&FP) — 16-bit
1x	0	11	UNALLOCATED
1x	1	1x	UNALLOCATED
10	0	00	STR (immediate) — 32-bit
10	0	01	LDR (immediate) — 32-bit
10	0	10	LDRSW (immediate)
10	1	00	STR (immediate, SIMD&FP) — 32-bit
10	1	01	LDR (immediate, SIMD&FP) — 32-bit
11	0	00	STR (immediate) — 64-bit
11	0	01	LDR (immediate) — 64-bit
11	01	1000	— 64-bitPRFM (immediate)STR (immediate, SIMD&FP)
11	1	0001	STR (immediate, SIMD&FP)LDR (immediate, SIMD&FP) — 64-bit
11	1	01	LDR (immediate, SIMD&FP) — 64-bit

Data Processing -- Register

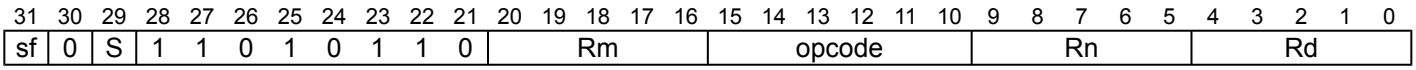
These instructions are under the top-level.



Decode fields				Instruction details
op0	op1	op2	op3	
0	1	0110		Data-processing (2 source)
1	1	0110		Data-processing (1 source)
	0	0xxx		Logical (shifted register)
	0	1xx0		Add/subtract (shifted register)
	0	1xx1		Add/subtract (extended register)
	1	0000	000000	Add/subtract (with carry)
	1	0000	x00001	Rotate right into flags
	1	0000	xx0010	Evaluate into flags
	1	0010	xxxx0x	Conditional compare (register)
	1	0010	xxxx1x	Conditional compare (immediate)
	1	0100		Conditional select
	1	1xxx		Data-processing (3 source)

Data-processing (2 source)

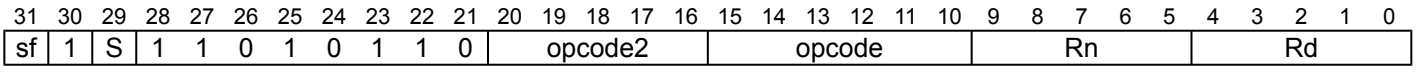
These instructions are under Data Processing -- Register.



Decode fields			Instruction Details	Architecture Version
sf	S	opcode		
		000001	UNALLOCATED	-
		011xxx	UNALLOCATED	-
		1xxxxx	UNALLOCATED	-
	0	00011x	UNALLOCATED	-
	0	001101	UNALLOCATED	-
	0	00111x	UNALLOCATED	-
	1	00001x	UNALLOCATED	-
	1	0001xx	UNALLOCATED	-
	1	001xxx	UNALLOCATED	-
	1	01xxxx	UNALLOCATED	-
0		000000	UNALLOCATED	-
0	0	000010	UDIV — 32-bit	-
0	0	000011	SDIV — 32-bit	-
0	0	00010x	UNALLOCATED	-
0	0	001000	LSLV — 32-bit	-
0	0	001001	LSRV — 32-bit	-
0	0	001010	ASRV — 32-bit	-
0	0	001011	RORV — 32-bit	-
0	0	001100	UNALLOCATED	-
0	0	010x11	UNALLOCATED	-
0	0	010000	CRC32B, CRC32H, CRC32W, CRC32X — CRC32B	-
0	0	010001	CRC32B, CRC32H, CRC32W, CRC32X — CRC32H	-
0	0	010010	CRC32B, CRC32H, CRC32W, CRC32X — CRC32W	-
0	0	010100	CRC32CB, CRC32CH, CRC32CW, CRC32CX — CRC32CB	-
0	0	010101	CRC32CB, CRC32CH, CRC32CW, CRC32CX — CRC32CH	-
0	0	010110	CRC32CB, CRC32CH, CRC32CW, CRC32CX — CRC32CW	-
1	0	000000	SUBP	Armv8.5
1	0	000010	UDIV — 64-bit	-
1	0	000011	SDIV — 64-bit	-
1	0	000100	IRG	Armv8.5
1	0	000101	GMI	Armv8.5
1	0	001000	LSLV — 64-bit	-
1	0	001001	LSRV — 64-bit	-
1	0	001010	ASRV — 64-bit	-
1	0	001011	RORV — 64-bit	-
1	0	001100	PACGA	Armv8.3
1	0	010xx0	UNALLOCATED	-
1	0	010x0x	UNALLOCATED	-
1	0	010011	CRC32B, CRC32H, CRC32W, CRC32X — CRC32X	-
1	0	010111	CRC32CB, CRC32CH, CRC32CW, CRC32CX — CRC32CX	-
1	1	000000	SUBPS	Armv8.5

Data-processing (1 source)

These instructions are under Data Processing -- Register.



Decode fields					Instruction Details	Architecture Version
sf	S	opcode2	opcode	Rn		
			1xxxxx		UNALLOCATED	-
		xxx1x			UNALLOCATED	-
		xx1xx			UNALLOCATED	-
		x1xxx			UNALLOCATED	-
		1xxxx			UNALLOCATED	-
	0	00000	00011x		UNALLOCATED	-
	0	00000	001xxx		UNALLOCATED	-
	0	00000	01xxxx		UNALLOCATED	-
	1				UNALLOCATED	-
0		00001			UNALLOCATED	-
0	0	00000	000000		RBIT — 32-bit	-
0	0	00000	000001		REV16 — 32-bit	-
0	0	00000	000010		REV — 32-bit	-
0	0	00000	000011		UNALLOCATED	-
0	0	00000	000100		CLZ — 32-bit	-
0	0	00000	000101		CLS — 32-bit	-
1	0	00000	000000		RBIT — 64-bit	-
1	0	00000	000001		REV16 — 64-bit	-
1	0	00000	000010		REV32	-
1	0	00000	000011		REV — 64-bit	-
1	0	00000	000100		CLZ — 64-bit	-
1	0	00000	000101		CLS — 64-bit	-
1	0	00001	000000		PACIA, PACIA1716, PACIASP, PACIAZ, PACIZA — PACIA	Armv8.3
1	0	00001	000001		PACIB, PACIB1716, PACIBSP, PACIBZ, PACIZB — PACIB	Armv8.3
1	0	00001	000010		PACDA, PACDZA — PACDA	Armv8.3
1	0	00001	000011		PACDB, PACDZB — PACDB	Armv8.3
1	0	00001	000100		AUTIA, AUTIA1716, AUTIASP, AUTIAZ, AUTIZA — AUTIA	Armv8.3
1	0	00001	000101		AUTIB, AUTIB1716, AUTIBSP, AUTIBZ, AUTIZB — AUTIB	Armv8.3
1	0	00001	000110		AUTDA, AUTDZA — AUTDA	Armv8.3
1	0	00001	000111		AUTDB, AUTDZB — AUTDB	Armv8.3
1	0	00001	001000	11111	PACIA, PACIA1716, PACIASP, PACIAZ, PACIZA — PACIZA	Armv8.3
1	0	00001	001001	11111	PACIB, PACIB1716, PACIBSP, PACIBZ, PACIZB — PACIZB	Armv8.3
1	0	00001	001010	11111	PACDA, PACDZA — PACDZA	Armv8.3
1	0	00001	001011	11111	PACDB, PACDZB — PACDZB	Armv8.3
1	0	00001	001100	11111	AUTIA, AUTIA1716, AUTIASP, AUTIAZ, AUTIZA — AUTIZA	Armv8.3
1	0	00001	001101	11111	AUTIB, AUTIB1716, AUTIBSP, AUTIBZ, AUTIZB — AUTIZB	Armv8.3
1	0	00001	001110	11111	AUTDA, AUTDZA — AUTDZA	Armv8.3
1	0	00001	001111	11111	AUTDB, AUTDZB — AUTDZB	Armv8.3
1	0	00001	010000	11111	XPACD, XPACI, XPACLRI — XPACI	Armv8.3

Decode fields					Instruction Details	Architecture Version
sf	S	opcode2	opcode	Rn		
1	0	00001	010001	11111	XPACD, XPACI, XPACLRI — XPACD	Armv8.3
1	0	00001	01001x		UNALLOCATED	-
1	0	00001	0101xx		UNALLOCATED	-
1	0	00001	011xxx		UNALLOCATED	-

Logical (shifted register)

These instructions are under Data Processing -- Register.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sf	opc		0	1	0	1	0	shift		N	Rm					imm6						Rn					Rd				

Decode fields				Instruction Details
sf	opc	N	imm6	
0			1xxxxx	UNALLOCATED
0	00	0		AND (shifted register) — 32-bit
0	00	1		BIC (shifted register) — 32-bit
0	01	0		ORR (shifted register) — 32-bit
0	01	1		ORN (shifted register) — 32-bit
0	10	0		EOR (shifted register) — 32-bit
0	10	1		EON (shifted register) — 32-bit
0	11	0		ANDS (shifted register) — 32-bit
0	11	1		BICS (shifted register) — 32-bit
1	00	0		AND (shifted register) — 64-bit
1	00	1		BIC (shifted register) — 64-bit
1	01	0		ORR (shifted register) — 64-bit
1	01	1		ORN (shifted register) — 64-bit
1	10	0		EOR (shifted register) — 64-bit
1	10	1		EON (shifted register) — 64-bit
1	11	0		ANDS (shifted register) — 64-bit
1	11	1		BICS (shifted register) — 64-bit

Add/subtract (shifted register)

These instructions are under Data Processing -- Register.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sf	op	S	0	1	0	1	1	shift		0	Rm					imm6						Rn					Rd				

Decode fields					Instruction Details
sf	op	S	shift	imm6	
			11		UNALLOCATED
0				1xxxxx	UNALLOCATED
0	0	0			ADD (shifted register) — 32-bit
0	0	1			ADDS (shifted register) — 32-bit
0	1	0			SUB (shifted register) — 32-bit
0	1	1			SUBS (shifted register) — 32-bit
1	0	0			ADD (shifted register) — 64-bit
1	0	1			ADDS (shifted register) — 64-bit
1	1	0			SUB (shifted register) — 64-bit

Decode fields					Instruction Details
sf	op	S	shift	imm6	
1	1	1			SUBS (shifted register) — 64-bit

Add/subtract (extended register)

These instructions are under Data Processing -- Register.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sf	op	S	0	1	0	1	1	opt		1	Rm					option			imm3			Rn					Rd				

Decode fields					Instruction Details
sf	op	S	opt	imm3	
				1x1	UNALLOCATED
				11x	UNALLOCATED
			x1		UNALLOCATED
			1x		UNALLOCATED
0	0	0	00		ADD (extended register) — 32-bit
0	0	1	00		ADDS (extended register) — 32-bit
0	1	0	00		SUB (extended register) — 32-bit
0	1	1	00		SUBS (extended register) — 32-bit
1	0	0	00		ADD (extended register) — 64-bit
1	0	1	00		ADDS (extended register) — 64-bit
1	1	0	00		SUB (extended register) — 64-bit
1	1	1	00		SUBS (extended register) — 64-bit

Add/subtract (with carry)

These instructions are under Data Processing -- Register.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sf	op	S	1	1	0	1	0	0	0	0	Rm					0	0	0	0	0	0	Rn					Rd				

Decode fields			Instruction Details
sf	op	S	
0	0	0	ADC — 32-bit
0	0	1	ADCS — 32-bit
0	1	0	SBC — 32-bit
0	1	1	SBCS — 32-bit
1	0	0	ADC — 64-bit
1	0	1	ADCS — 64-bit
1	1	0	SBC — 64-bit
1	1	1	SBCS — 64-bit

Rotate right into flags

These instructions are under Data Processing -- Register.

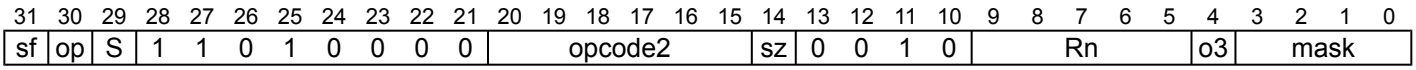
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sf	op	S	1	1	0	1	0	0	0	0	imm6						0	0	0	0	1	Rn					o2	mask				

Decode fields				Instruction Details	Architecture Version
sf	op	S	o2		
0				UNALLOCATED	-

Decode fields				Instruction Details	Architecture Version
sf	op	S	o2		
1	0	0		UNALLOCATED	-
1	0	1	0	RMIF	Armv8.4
1	0	1	1	UNALLOCATED	-
1	1			UNALLOCATED	-

Evaluate into flags

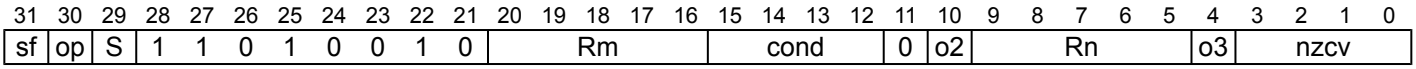
These instructions are under Data Processing -- Register.



Decode fields							Instruction Details	Architecture Version
sf	op	S	opcode2	sz	o3	mask		
0	0	0					UNALLOCATED	-
0	0	1	!= 000000				UNALLOCATED	-
0	0	1	000000		0	!= 1101	UNALLOCATED	-
0	0	1	000000		1		UNALLOCATED	-
0	0	1	000000	0	0	1101	SETF8, SETF16 — SETF8	Armv8.4
0	0	1	000000	1	0	1101	SETF8, SETF16 — SETF16	Armv8.4
0	1						UNALLOCATED	-
1							UNALLOCATED	-

Conditional compare (register)

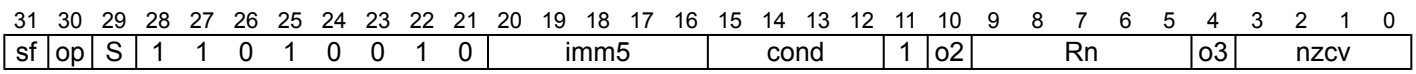
These instructions are under Data Processing -- Register.



Decode fields					Instruction Details
sf	op	S	o2	o3	
				1	UNALLOCATED
			1		UNALLOCATED
		0			UNALLOCATED
0	0	1	0	0	CCMN (register) — 32-bit
0	1	1	0	0	CCMP (register) — 32-bit
1	0	1	0	0	CCMN (register) — 64-bit
1	1	1	0	0	CCMP (register) — 64-bit

Conditional compare (immediate)

These instructions are under Data Processing -- Register.

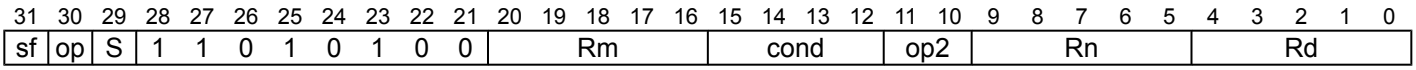


Decode fields					Instruction Details
sf	op	S	o2	o3	
				1	UNALLOCATED
			1		UNALLOCATED
		0			UNALLOCATED

Decode fields					Instruction Details
sf	op	S	o2	o3	
0	0	1	0	0	CCMN (immediate) — 32-bit
0	1	1	0	0	CCMP (immediate) — 32-bit
1	0	1	0	0	CCMN (immediate) — 64-bit
1	1	1	0	0	CCMP (immediate) — 64-bit

Conditional select

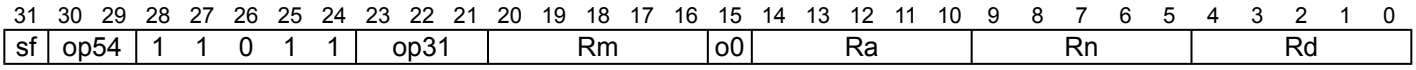
These instructions are under Data Processing -- Register.



Decode fields				Instruction Details
sf	op	S	op2	
			1x	UNALLOCATED
		1		UNALLOCATED
0	0	0	00	CSEL — 32-bit
0	0	0	01	CSINC — 32-bit
0	1	0	00	CSINV — 32-bit
0	1	0	01	CSNEG — 32-bit
1	0	0	00	CSEL — 64-bit
1	0	0	01	CSINC — 64-bit
1	1	0	00	CSINV — 64-bit
1	1	0	01	CSNEG — 64-bit

Data-processing (3 source)

These instructions are under Data Processing -- Register.

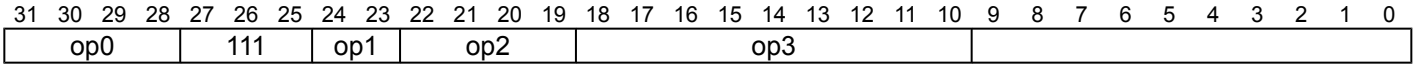


Decode fields				Instruction Details
sf	op54	op31	o0	
	00	010	1	UNALLOCATED
	00	011		UNALLOCATED
	00	100		UNALLOCATED
	00	110	1	UNALLOCATED
	00	111		UNALLOCATED
	01			UNALLOCATED
	1x			UNALLOCATED
0	00	000	0	MADD — 32-bit
0	00	000	1	MSUB — 32-bit
0	00	001	0	UNALLOCATED
0	00	001	1	UNALLOCATED
0	00	010	0	UNALLOCATED
0	00	101	0	UNALLOCATED
0	00	101	1	UNALLOCATED
0	00	110	0	UNALLOCATED
1	00	000	0	MADD — 64-bit

Decode fields				Instruction Details
sf	op54	op31	o0	
1	00	000	1	MSUB — 64-bit
1	00	001	0	SMADDL
1	00	001	1	SMSUBL
1	00	010	0	SMULH
1	00	101	0	UMADDL
1	00	101	1	UMSUBL
1	00	110	0	UMULH

Data Processing -- Scalar Floating-Point and Advanced SIMD

These instructions are under the top-level.

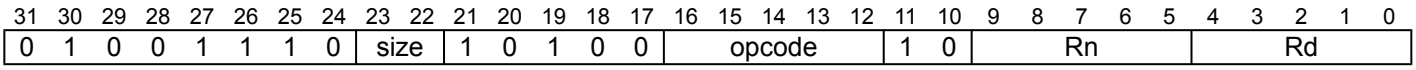


Decode fields				Instruction details	Architecture version
op0	op1	op2	op3		
0000	0x	x101	00xxxxx10	UNALLOCATED	-
0010	0x	x101	00xxxxx10	UNALLOCATED	-
0100	0x	x101	00xxxxx10	Cryptographic AES	-
0101	0x	x0xx	xxx0xxx00	Cryptographic three-register SHA	-
0101	0x	x0xx	xxx0xxx10	UNALLOCATED	-
0101	0x	x101	00xxxxx10	Cryptographic two-register SHA	-
0110	0x	x101	00xxxxx10	UNALLOCATED	-
0111	0x	x0xx	xxx0xxxx0	UNALLOCATED	-
0111	0x	x101	00xxxxx10	UNALLOCATED	-
01x1	00	00xx	xxx0xxxx1	Advanced SIMD scalar copy	-
01x1	01	00xx	xxx0xxxx1	UNALLOCATED	-
01x1	0x	0111	00xxxxx10	UNALLOCATED	-
01x1	0x	10xx	xxx00xxx1	Advanced SIMD scalar three same FP16	Armv8.2
01x1	0x	10xx	xxx01xxx1	UNALLOCATED	-
01x1	0x	1111	00xxxxx10	Advanced SIMD scalar two-register miscellaneous FP16	Armv8.2
01x1	0x	x0xx	xxx1xxxx0	UNALLOCATED	-
01x1	0x	x0xx	xxx1xxxx1	Advanced SIMD scalar three same extra	Armv8.1
01x1	0x	x100	00xxxxx10	Advanced SIMD scalar two-register miscellaneous	-
01x1	0x	x110	00xxxxx10	Advanced SIMD scalar pairwise	Armv8.2
01x1	0x	x1xx	1xxxxxx10	UNALLOCATED	-
01x1	0x	x1xx	x1xxxxx10	UNALLOCATED	-
01x1	0x	x1xx	xxxxxxx00	Advanced SIMD scalar three different	-
01x1	0x	x1xx	xxxxxxxx1	Advanced SIMD scalar three same	-
01x1	10		xxxxxxxx1	Advanced SIMD scalar shift by immediate	-
01x1	11		xxxxxxxx1	UNALLOCATED	-
01x1	1x		xxxxxxxx0	Advanced SIMD scalar x indexed element	Armv8.2
0x00	0x	x0xx	xxx0xxx00	Advanced SIMD table lookup	-
0x00	0x	x0xx	xxx0xxx10	Advanced SIMD permute	-
0x10	0x	x0xx	xxx0xxxx0	Advanced SIMD extract	-
0xx0	00	00xx	xxx0xxxx1	Advanced SIMD copy	-
0xx0	01	00xx	xxx0xxxx1	UNALLOCATED	-

0xx0	0x	0111	00xxxxx10	UNALLOCATED	-
0xx0	0x	10xx	xxx00xxx1	Advanced SIMD three same (FP16)	Armv8.2
0xx0	0x	10xx	xxx01xxx1	UNALLOCATED	-
0xx0	0x	1111	00xxxxx10	Advanced SIMD two-register miscellaneous (FP16)	Armv8.2
0xx0	0x	x0xx	xxx1xxxx0	UNALLOCATED	-
0xx0	0x	x0xx	xxx1xxxx1	Advanced SIMD three same extra	Armv8.2
0xx0	0x	x100	00xxxxx10	Advanced SIMD two-register miscellaneous	Armv8.5
0xx0	0x	x110	00xxxxx10	Advanced SIMD across lanes	Armv8.2
0xx0	0x	x1xx	1xxxxxx10	UNALLOCATED	-
0xx0	0x	x1xx	x1xxxxx10	UNALLOCATED	-
0xx0	0x	x1xx	xxxxxxx00	Advanced SIMD three different	-
0xx0	0x	x1xx	xxxxxxxx1	Advanced SIMD three same	Armv8.2
0xx0	10	0000	xxxxxxxx1	Advanced SIMD modified immediate	Armv8.2
0xx0	10	!= 0000	xxxxxxxx1	Advanced SIMD shift by immediate	-
0xx0	11		xxxxxxxx1	UNALLOCATED	-
0xx0	1x		xxxxxxxx0	Advanced SIMD vector x indexed element	Armv8.2
1100	00	10xx	xxx10xxxx	Cryptographic three-register, imm2	Armv8.2
1100	00	11xx	xxx1x00xx	Cryptographic three-register SHA 512	Armv8.2
1100	00		xxx0xxxxx	Cryptographic four-register	Armv8.2
1100	01	00xx		XAR	Armv8.2
1100	01	1000	0001000xx	Cryptographic two-register SHA 512	Armv8.2
1xx0	1x			UNALLOCATED	-
x0x1	0x	x0xx		Conversion between floating-point and fixed-point	Armv8.2
x0x1	0x	x1xx	xxx000000	Conversion between floating-point and integer	Armv8.3
x0x1	0x	x1xx	xxxx10000	Floating-point data-processing (1 source)	Armv8.5
x0x1	0x	x1xx	xxxxx1000	Floating-point compare	Armv8.2
x0x1	0x	x1xx	xxxxxx100	Floating-point immediate	Armv8.2
x0x1	0x	x1xx	xxxxxxx01	Floating-point conditional compare	Armv8.2
x0x1	0x	x1xx	xxxxxxx10	Floating-point data-processing (2 source)	Armv8.2
x0x1	0x	x1xx	xxxxxxx11	Floating-point conditional select	Armv8.2
x0x1	1x			Floating-point data-processing (3 source)	Armv8.2

Cryptographic AES

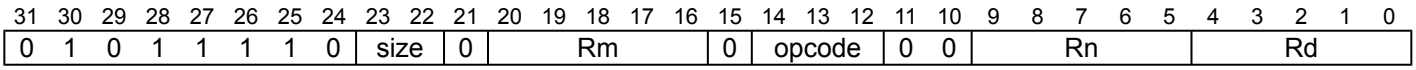
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields size	opcode	Instruction Details
	x1xxx	UNALLOCATED
	000xx	UNALLOCATED
	1xxxx	UNALLOCATED
x1		UNALLOCATED
00	00100	AESE
00	00101	AESD
00	00110	AESMC
00	00111	AESIMC
1x		UNALLOCATED

Cryptographic three-register SHA

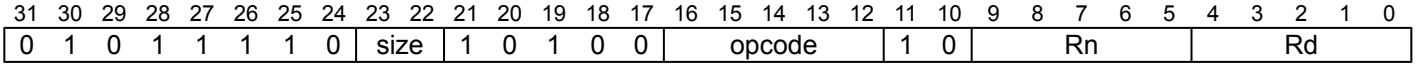
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields size	Decode fields opcode	Instruction Details
	111	UNALLOCATED
x1		UNALLOCATED
00	000	SHA1C
00	001	SHA1P
00	010	SHA1M
00	011	SHA1SU0
00	100	SHA256H
00	101	SHA256H2
00	110	SHA256SU1
1x		UNALLOCATED

Cryptographic two-register SHA

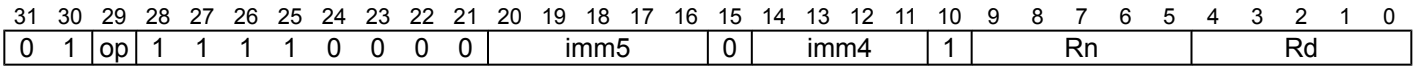
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields size	Decode fields opcode	Instruction Details
	xx1xx	UNALLOCATED
	x1xxx	UNALLOCATED
	1xxxx	UNALLOCATED
x1		UNALLOCATED
00	00000	SHA1H
00	00001	SHA1SU1
00	00010	SHA256SU0
00	00011	UNALLOCATED
1x		UNALLOCATED

Advanced SIMD scalar copy

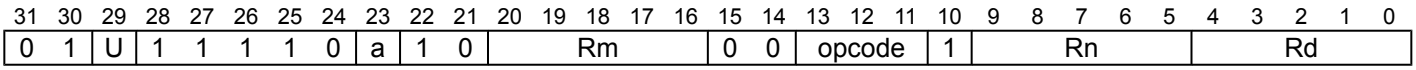
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields op	Decode fields imm5	Decode fields imm4	Instruction Details
0		xxx1	UNALLOCATED
0		xx1x	UNALLOCATED
0		x1xx	UNALLOCATED
0		0000	DUP (element)
0		1xxx	UNALLOCATED
0	x0000	0000	UNALLOCATED
1			UNALLOCATED

Advanced SIMD scalar three same FP16

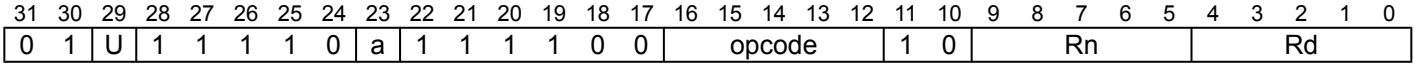
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields U	a	opcode	Instruction Details	Architecture Version
		110	UNALLOCATED	-
	1	011	UNALLOCATED	-
0	0	011	FMULX	Armv8.2
0	0	100	FCMEQ (register)	Armv8.2
0	0	101	UNALLOCATED	-
0	0	111	FRECPS	Armv8.2
0	1	100	UNALLOCATED	-
0	1	101	UNALLOCATED	-
0	1	111	FRSQRTS	Armv8.2
1	0	011	UNALLOCATED	-
1	0	100	FCMGE (register)	Armv8.2
1	0	101	FACGE	Armv8.2
1	0	111	UNALLOCATED	-
1	1	010	FABD	Armv8.2
1	1	100	FCMGT (register)	Armv8.2
1	1	101	FACGT	Armv8.2
1	1	111	UNALLOCATED	-

Advanced SIMD scalar two-register miscellaneous FP16

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields U	a	opcode	Instruction Details	Architecture Version
		00xxx	UNALLOCATED	-
		010xx	UNALLOCATED	-
		10xxx	UNALLOCATED	-
		1100x	UNALLOCATED	-
		11110	UNALLOCATED	-
	0	011xx	UNALLOCATED	-
	0	11111	UNALLOCATED	-
	1	01111	UNALLOCATED	-
	1	11100	UNALLOCATED	-
0	0	11010	FCVTNS (vector)	Armv8.2
0	0	11011	FCVTMS (vector)	Armv8.2
0	0	11100	FCVTAS (vector)	Armv8.2
0	0	11101	SCVTF (vector, integer)	Armv8.2
0	1	01100	FCMGT (zero)	Armv8.2
0	1	01101	FCMEQ (zero)	Armv8.2
0	1	01110	FCMLT (zero)	Armv8.2
0	1	11010	FCVTPS (vector)	Armv8.2

Decode fields U	a	opcode	Instruction Details	Architecture Version
0	1	11011	FCVTZS (vector, integer)	Armv8.2
0	1	11101	FRECPE	Armv8.2
0	1	11111	FRECPX	Armv8.2
1	0	11010	FCVTNU (vector)	Armv8.2
1	0	11011	FCVTMU (vector)	Armv8.2
1	0	11100	FCVTAU (vector)	Armv8.2
1	0	11101	UCVTF (vector, integer)	Armv8.2
1	1	01100	FCMGE (zero)	Armv8.2
1	1	01101	FCMLE (zero)	Armv8.2
1	1	01110	UNALLOCATED	-
1	1	11010	FCVTPU (vector)	Armv8.2
1	1	11011	FCVTZU (vector, integer)	Armv8.2
1	1	11101	FRSQRTE	Armv8.2
1	1	11111	UNALLOCATED	-

Advanced SIMD scalar three same extra

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	U	1	1	1	1	0	size		0	Rm					1	opcode				1	Rn					Rd				

Decode fields U	opcode	Instruction Details	Architecture Version
	001x	UNALLOCATED	-
	01xx	UNALLOCATED	-
	1xxx	UNALLOCATED	-
0	0000	UNALLOCATED	-
0	0001	UNALLOCATED	-
1	0000	SQRDMLAH (vector)	Armv8.1
1	0001	SQRDMLSH (vector)	Armv8.1

Advanced SIMD scalar two-register miscellaneous

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

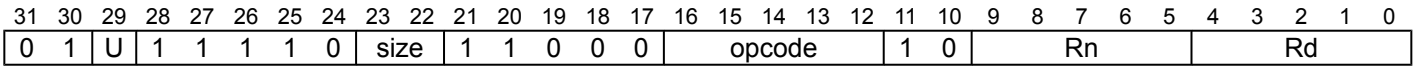
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	U	1	1	1	1	0	size		1	0	0	0	0	opcode					1	0	Rn					Rd				

Decode fields U	size	opcode	Instruction Details
		0000x	UNALLOCATED
		00010	UNALLOCATED
		0010x	UNALLOCATED
		00110	UNALLOCATED
		01111	UNALLOCATED
		1000x	UNALLOCATED
		10011	UNALLOCATED
		10101	UNALLOCATED
		10111	UNALLOCATED

Decode fields			Instruction Details
U	size	opcode	
		1100x	UNALLOCATED
		11110	UNALLOCATED
	0x	011xx	UNALLOCATED
	0x	11111	UNALLOCATED
	1x	10110	UNALLOCATED
	1x	11100	UNALLOCATED
0		00011	SUQADD
0		00111	SQABS
0		01000	CMGT (zero)
0		01001	CMEQ (zero)
0		01010	CMLT (zero)
0		01011	ABS
0		10010	UNALLOCATED
0		10100	SQXTN, SQXTN2
0	0x	10110	UNALLOCATED
0	0x	11010	FCVTNS (vector)
0	0x	11011	FCVTMS (vector)
0	0x	11100	FCVTAS (vector)
0	0x	11101	SCVTF (vector, integer)
0	1x	01100	FCMGT (zero)
0	1x	01101	FCMEQ (zero)
0	1x	01110	FCMLT (zero)
0	1x	11010	FCVTPS (vector)
0	1x	11011	FCVTZS (vector, integer)
0	1x	11101	FRECPE
0	1x	11111	FRECPX
1		00011	USQADD
1		00111	SQNEG
1		01000	CMGE (zero)
1		01001	CMLE (zero)
1		01010	UNALLOCATED
1		01011	NEG (vector)
1		10010	SQXTUN, SQXTUN2
1		10100	UQXTN, UQXTN2
1	0x	10110	FCVTXN, FCVTXN2
1	0x	11010	FCVTNU (vector)
1	0x	11011	FCVTMU (vector)
1	0x	11100	FCVTAU (vector)
1	0x	11101	UCVTF (vector, integer)
1	1x	01100	FCMGE (zero)
1	1x	01101	FCMLE (zero)
1	1x	01110	UNALLOCATED
1	1x	11010	FCVTPU (vector)
1	1x	11011	FCVTZU (vector, integer)
1	1x	11101	FRSQRTE
1	1x	11111	UNALLOCATED

Advanced SIMD scalar pairwise

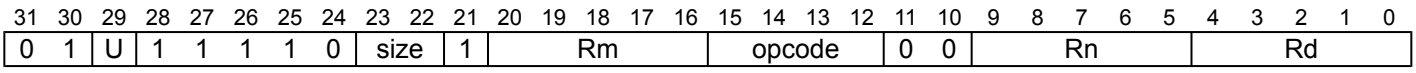
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields U	size	opcode	Instruction Details	Architecture Version
		00xxx	UNALLOCATED	-
		010xx	UNALLOCATED	-
		01110	UNALLOCATED	-
		10xxx	UNALLOCATED	-
		1100x	UNALLOCATED	-
		11010	UNALLOCATED	-
		111xx	UNALLOCATED	-
	1x	01101	UNALLOCATED	-
0		11011	ADDP (scalar)	-
0	00	01100	FMAXNMP (scalar) — half-precision	Armv8.2
0	00	01101	FADDP (scalar) — half-precision	Armv8.2
0	00	01111	FMAXP (scalar) — half-precision	Armv8.2
0	01	01100	UNALLOCATED	-
0	01	01101	UNALLOCATED	-
0	01	01111	UNALLOCATED	-
0	10	01100	FMINNMP (scalar) — half-precision	Armv8.2
0	10	01111	FMINP (scalar) — half-precision	Armv8.2
0	11	01100	UNALLOCATED	-
0	11	01111	UNALLOCATED	-
1		11011	UNALLOCATED	-
1	0x	01100	FMAXNMP (scalar) — single-precision and double-precision	-
1	0x	01101	FADDP (scalar) — single-precision and double-precision	-
1	0x	01111	FMAXP (scalar) — single-precision and double-precision	-
1	1x	01100	FMINNMP (scalar) — single-precision and double-precision	-
1	1x	01111	FMINP (scalar) — single-precision and double-precision	-

Advanced SIMD scalar three different

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

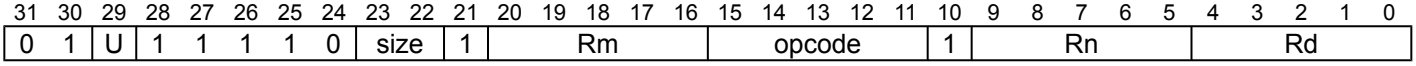


Decode fields U	opcode	Instruction Details
	00xx	UNALLOCATED
	01xx	UNALLOCATED
	1000	UNALLOCATED
	1010	UNALLOCATED
	1100	UNALLOCATED
	111x	UNALLOCATED
0	1001	SQDMLAL, SQDMLAL2 (vector)
0	1011	SQDMLSL, SQDMLSL2 (vector)
0	1101	SQDMULL, SQDMULL2 (vector)

Decode fields U	opcode	Instruction Details
1	1001	UNALLOCATED
1	1011	UNALLOCATED
1	1101	UNALLOCATED

Advanced SIMD scalar three same

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

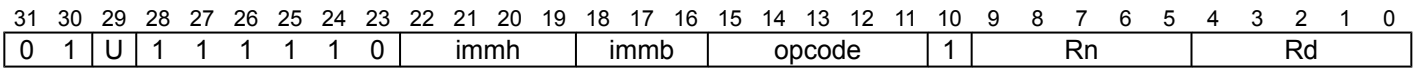


Decode fields U	size	opcode	Instruction Details
		00000	UNALLOCATED
		0001x	UNALLOCATED
		00100	UNALLOCATED
		011xx	UNALLOCATED
		1001x	UNALLOCATED
	1x	11011	UNALLOCATED
0		00001	SQADD
0		00101	SQSUB
0		00110	CMGT (register)
0		00111	CMGE (register)
0		01000	SSHL
0		01001	SQSHL (register)
0		01010	SRSHL
0		01011	SQRSHL
0		10000	ADD (vector)
0		10001	CMTST
0		10100	UNALLOCATED
0		10101	UNALLOCATED
0		10110	SQDMULH (vector)
0		10111	UNALLOCATED
0	0x	11000	UNALLOCATED
0	0x	11001	UNALLOCATED
0	0x	11010	UNALLOCATED
0	0x	11011	FMULX
0	0x	11100	FCMEQ (register)
0	0x	11101	UNALLOCATED
0	0x	11110	UNALLOCATED
0	0x	11111	FRECPS
0	1x	11000	UNALLOCATED
0	1x	11001	UNALLOCATED
0	1x	11010	UNALLOCATED
0	1x	11100	UNALLOCATED
0	1x	11101	UNALLOCATED
0	1x	11110	UNALLOCATED
0	1x	11111	FRSQRTS
1		00001	UQADD

Decode fields			Instruction Details
U	size	opcode	
1		00101	UQSUB
1		00110	CMHI (register)
1		00111	CMHS (register)
1		01000	USHL
1		01001	UQSHL (register)
1		01010	URSHL
1		01011	UQRSHL
1		10000	SUB (vector)
1		10001	CMEQ (register)
1		10100	UNALLOCATED
1		10101	UNALLOCATED
1		10110	SQRDMULH (vector)
1		10111	UNALLOCATED
1	0x	11000	UNALLOCATED
1	0x	11001	UNALLOCATED
1	0x	11010	UNALLOCATED
1	0x	11011	UNALLOCATED
1	0x	11100	FCMGE (register)
1	0x	11101	FACGE
1	0x	11110	UNALLOCATED
1	0x	11111	UNALLOCATED
1	1x	11000	UNALLOCATED
1	1x	11001	UNALLOCATED
1	1x	11010	FABD
1	1x	11100	FCMGT (register)
1	1x	11101	FACGT
1	1x	11110	UNALLOCATED
1	1x	11111	UNALLOCATED

Advanced SIMD scalar shift by immediate

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields			Instruction Details
U	immh	opcode	
	!= 0000	00001	UNALLOCATED
	!= 0000	00011	UNALLOCATED
	!= 0000	00101	UNALLOCATED
	!= 0000	00111	UNALLOCATED
	!= 0000	01001	UNALLOCATED
	!= 0000	01011	UNALLOCATED
	!= 0000	01101	UNALLOCATED
	!= 0000	01111	UNALLOCATED
	!= 0000	101xx	UNALLOCATED
	!= 0000	110xx	UNALLOCATED
	!= 0000	11101	UNALLOCATED

Decode fields			Instruction Details
U	immh	opcode	
	!= 0000	11110	UNALLOCATED
	0000		UNALLOCATED
0	!= 0000	00000	SSHR
0	!= 0000	00010	SSRA
0	!= 0000	00100	SRSHR
0	!= 0000	00110	SRSRA
0	!= 0000	01000	UNALLOCATED
0	!= 0000	01010	SHL
0	!= 0000	01100	UNALLOCATED
0	!= 0000	01110	SQSHL (immediate)
0	!= 0000	10000	UNALLOCATED
0	!= 0000	10001	UNALLOCATED
0	!= 0000	10010	SQSHRN, SQSHRN2
0	!= 0000	10011	SQRSHRN, SQRSHRN2
0	!= 0000	11100	SCVTF (vector, fixed-point)
0	!= 0000	11111	FCVTZS (vector, fixed-point)
1	!= 0000	00000	USHR
1	!= 0000	00010	USRA
1	!= 0000	00100	URSHR
1	!= 0000	00110	URSRA
1	!= 0000	01000	SRI
1	!= 0000	01010	SLI
1	!= 0000	01100	SQSHLU
1	!= 0000	01110	UQSHL (immediate)
1	!= 0000	10000	SQSHRUN, SQSHRUN2
1	!= 0000	10001	SQRSHRUN, SQRSHRUN2
1	!= 0000	10010	UQSHRN, UQSHRN2
1	!= 0000	10011	UQRSHRN, UQRSHRN2
1	!= 0000	11100	UCVTF (vector, fixed-point)
1	!= 0000	11111	FCVTZU (vector, fixed-point)

Advanced SIMD scalar x indexed element

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	U	1	1	1	1	1	size		L	M	Rm				opcode				H	0	Rn						Rd			

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
		0000	UNALLOCATED	-
		0010	UNALLOCATED	-
		0100	UNALLOCATED	-
		0110	UNALLOCATED	-
		1000	UNALLOCATED	-
		1010	UNALLOCATED	-
		1110	UNALLOCATED	-
	01	0001	UNALLOCATED	-
	01	0101	UNALLOCATED	-

Decode fields U	size	opcode	Instruction Details	Architecture Version
	01	1001	UNALLOCATED	-
0		0011	SQDMLAL, SQDMLAL2 (by element)	-
0		0111	SQDMLSL, SQDMLSL2 (by element)	-
0		1011	SQDMULL, SQDMULL2 (by element)	-
0		1100	SQDMULH (by element)	-
0		1101	SQRDMULH (by element)	-
0		1111	UNALLOCATED	-
0	00	0001	FMLA (by element) — half-precision	Armv8.2
0	00	0101	FMLS (by element) — half-precision	Armv8.2
0	00	1001	FMUL (by element) — half-precision	Armv8.2
0	1x	0001	FMLA (by element) — single-precision and double-precision	-
0	1x	0101	FMLS (by element) — single-precision and double-precision	-
0	1x	1001	FMUL (by element) — single-precision and double-precision	-
1		0011	UNALLOCATED	-
1		0111	UNALLOCATED	-
1		1011	UNALLOCATED	-
1		1100	UNALLOCATED	-
1		1101	SQRDMLAH (by element)	Armv8.1
1		1111	SQRDMLSH (by element)	Armv8.1
1	00	0001	UNALLOCATED	-
1	00	0101	UNALLOCATED	-
1	00	1001	FMULX (by element) — half-precision	Armv8.2
1	1x	0001	UNALLOCATED	-
1	1x	0101	UNALLOCATED	-
1	1x	1001	FMULX (by element) — single-precision and double-precision	-

Advanced SIMD table lookup

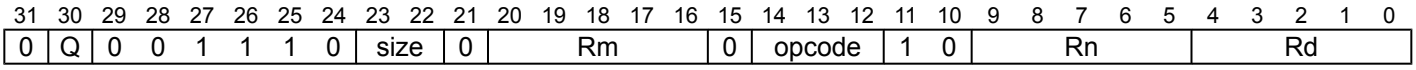
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	0	0	1	1	1	0	op2		0	Rm					0	len		op	0	0	Rn					Rd				

Decode fields op2	len	op	Instruction Details
x1			UNALLOCATED
00	00	0	TBL — single register table
00	00	1	TBX — single register table
00	01	0	TBL — two register table
00	01	1	TBX — two register table
00	10	0	TBL — three register table
00	10	1	TBX — three register table
00	11	0	TBL — four register table
00	11	1	TBX — four register table
1x			UNALLOCATED

Advanced SIMD permute

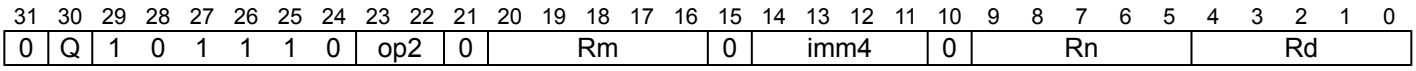
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields opcode	Instruction Details
000	UNALLOCATED
001	UZP1
010	TRN1
011	ZIP1
100	UNALLOCATED
101	UZP2
110	TRN2
111	ZIP2

Advanced SIMD extract

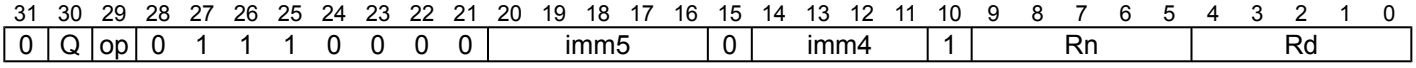
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields op2	Instruction Details
x1	UNALLOCATED
00	EXT
1x	UNALLOCATED

Advanced SIMD copy

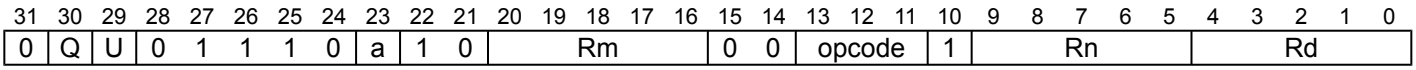
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields Q	op	imm5	imm4	Instruction Details
		x0000		UNALLOCATED
	0		0000	DUP (element)
	0		0001	DUP (general)
	0		0010	UNALLOCATED
	0		0100	UNALLOCATED
	0		0110	UNALLOCATED
	0		1xxx	UNALLOCATED
0	0		0011	UNALLOCATED
0	0		0101	SMOV
0	0		0111	UMOV
0	1			UNALLOCATED
1	0		0011	INS (general)
1	0		0101	SMOV
1	0	x1000	0111	UMOV
1	1			INS (element)

Advanced SIMD three same (FP16)

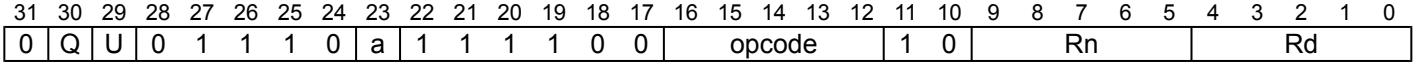
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields			Instruction Details	Architecture Version
U	a	opcode		
0	0	000	FMAXNM (vector)	Armv8.2
0	0	001	FMLA (vector)	Armv8.2
0	0	010	FADD (vector)	Armv8.2
0	0	011	FMULX	Armv8.2
0	0	100	FCMEQ (register)	Armv8.2
0	0	101	UNALLOCATED	-
0	0	110	FMAX (vector)	Armv8.2
0	0	111	FRECPS	Armv8.2
0	1	000	FMINNM (vector)	Armv8.2
0	1	001	FMLS (vector)	Armv8.2
0	1	010	FSUB (vector)	Armv8.2
0	1	011	UNALLOCATED	-
0	1	100	UNALLOCATED	-
0	1	101	UNALLOCATED	-
0	1	110	FMIN (vector)	Armv8.2
0	1	111	FRSQRTS	Armv8.2
1	0	000	FMAXNMP (vector)	Armv8.2
1	0	001	UNALLOCATED	-
1	0	010	FADDP (vector)	Armv8.2
1	0	011	FMUL (vector)	Armv8.2
1	0	100	FCMGE (register)	Armv8.2
1	0	101	FACGE	Armv8.2
1	0	110	FMAXP (vector)	Armv8.2
1	0	111	FDIV (vector)	Armv8.2
1	1	000	FMINNMP (vector)	Armv8.2
1	1	001	UNALLOCATED	-
1	1	010	FABD	Armv8.2
1	1	011	UNALLOCATED	-
1	1	100	FCMGT (register)	Armv8.2
1	1	101	FACGT	Armv8.2
1	1	110	FMINP (vector)	Armv8.2
1	1	111	UNALLOCATED	-

Advanced SIMD two-register miscellaneous (FP16)

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

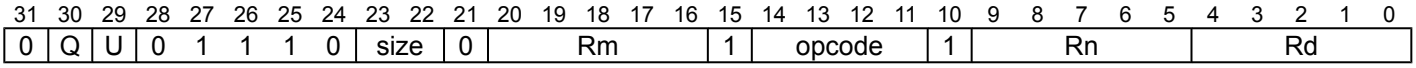


Decode fields			Instruction Details	Architecture Version
U	a	opcode		
		00xxx	UNALLOCATED	-
		010xx	UNALLOCATED	-

Decode fields			Instruction Details	Architecture Version
U	a	opcode		
		10xxx	UNALLOCATED	-
		11110	UNALLOCATED	-
	0	011xx	UNALLOCATED	-
	0	11111	UNALLOCATED	-
	1	11100	UNALLOCATED	-
0	0	11000	FRINTN (vector)	Armv8.2
0	0	11001	FRINTM (vector)	Armv8.2
0	0	11010	FCVTNS (vector)	Armv8.2
0	0	11011	FCVTMS (vector)	Armv8.2
0	0	11100	FCVTAS (vector)	Armv8.2
0	0	11101	SCVTF (vector, integer)	Armv8.2
0	1	01100	FCMGT (zero)	Armv8.2
0	1	01101	FCMEQ (zero)	Armv8.2
0	1	01110	FCMLT (zero)	Armv8.2
0	1	01111	FABS (vector)	Armv8.2
0	1	11000	FRINTP (vector)	Armv8.2
0	1	11001	FRINTZ (vector)	Armv8.2
0	1	11010	FCVTPS (vector)	Armv8.2
0	1	11011	FCVTZS (vector, integer)	Armv8.2
0	1	11101	FRECPE	Armv8.2
0	1	11111	UNALLOCATED	-
1	0	11000	FRINTA (vector)	Armv8.2
1	0	11001	FRINTX (vector)	Armv8.2
1	0	11010	FCVTNU (vector)	Armv8.2
1	0	11011	FCVTMU (vector)	Armv8.2
1	0	11100	FCVTAU (vector)	Armv8.2
1	0	11101	UCVTF (vector, integer)	Armv8.2
1	1	01100	FCMGE (zero)	Armv8.2
1	1	01101	FCMLE (zero)	Armv8.2
1	1	01110	UNALLOCATED	-
1	1	01111	FNEG (vector)	Armv8.2
1	1	11000	UNALLOCATED	-
1	1	11001	FRINTI (vector)	Armv8.2
1	1	11010	FCVTPU (vector)	Armv8.2
1	1	11011	FCVTZU (vector, integer)	Armv8.2
1	1	11101	FRSQRTE	Armv8.2
1	1	11111	FSQRT (vector)	Armv8.2

Advanced SIMD three same extra

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields			Instruction Details	Architecture Version
U	size	opcode		
		0011	UNALLOCATED	-
		01xx	UNALLOCATED	-

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
0		0000	UNALLOCATED	-
0		0001	UNALLOCATED	-
0		0010	SDOT (vector)	Armv8.2
0		1xxx	UNALLOCATED	-
1		0000	SQRDMLAH (vector)	Armv8.1
1		0001	SQRDMLSH (vector)	Armv8.1
1		0010	UDOT (vector)	Armv8.2
1		10xx	FCMLA	Armv8.3
1		11x0	FCADD	Armv8.3
1	00	1101	UNALLOCATED	-
1	00	1111	UNALLOCATED	-
1	1x	1101	UNALLOCATED	-
1	10	1111	UNALLOCATED	-

Advanced SIMD two-register miscellaneous

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	U	0	1	1	1	0	size		1	0	0	0	0	opcode					1	0	Rn					Rd				

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
		1000x	UNALLOCATED	-
		10101	UNALLOCATED	-
	0x	011xx	UNALLOCATED	-
	1x	10111	UNALLOCATED	-
	1x	11110	UNALLOCATED	-
	11	10110	UNALLOCATED	-
0		00000	REV64	-
0		00001	REV16 (vector)	-
0		00010	SADDLP	-
0		00011	SUQADD	-
0		00100	CLS (vector)	-
0		00101	CNT	-
0		00110	SADALP	-
0		00111	SQABS	-
0		01000	CMGT (zero)	-
0		01001	CMEQ (zero)	-
0		01010	CMLT (zero)	-
0		01011	ABS	-
0		10010	XTN, XTN2	-
0		10011	UNALLOCATED	-
0		10100	SQXTN, SQXTN2	-
0	0x	10110	FCVTN, FCVTN2	-
0	0x	10111	FCVTL, FCVTL2	-
0	0x	11000	FRINTN (vector)	-
0	0x	11001	FRINTM (vector)	-
0	0x	11010	FCVTNS (vector)	-

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
0	0x	11011	FCVTMS (vector)	-
0	0x	11100	FCVTAS (vector)	-
0	0x	11101	SCVTF (vector, integer)	-
0	0x	11110	FRINT32Z (vector)	Armv8.5
0	0x	11111	FRINT64Z (vector)	Armv8.5
0	1x	01100	FCMGT (zero)	-
0	1x	01101	FCMEQ (zero)	-
0	1x	01110	FCMLT (zero)	-
0	1x	01111	FABS (vector)	-
0	1x	11000	FRINTP (vector)	-
0	1x	11001	FRINTZ (vector)	-
0	1x	11010	FCVTPS (vector)	-
0	1x	11011	FCVTZS (vector, integer)	-
0	1x	11100	URECPE	-
0	1x	11101	FRECPE	-
0	1x	11111	UNALLOCATED	-
1		00000	REV32 (vector)	-
1		00001	UNALLOCATED	-
1		00010	UADDLP	-
1		00011	USQADD	-
1		00100	CLZ (vector)	-
1		00110	UADALP	-
1		00111	SQNEG	-
1		01000	CMGE (zero)	-
1		01001	CMLE (zero)	-
1		01010	UNALLOCATED	-
1		01011	NEG (vector)	-
1		10010	SQXTUN, SQXTUN2	-
1		10011	SHLL, SHLL2	-
1		10100	UQXTN, UQXTN2	-
1	0x	10110	FCVTXN, FCVTXN2	-
1	0x	10111	UNALLOCATED	-
1	0x	11000	FRINTA (vector)	-
1	0x	11001	FRINTX (vector)	-
1	0x	11010	FCVTNU (vector)	-
1	0x	11011	FCVTMU (vector)	-
1	0x	11100	FCVTAU (vector)	-
1	0x	11101	UCVTF (vector, integer)	-
1	0x	11110	FRINT32X (vector)	Armv8.5
1	0x	11111	FRINT64X (vector)	Armv8.5
1	00	00101	NOT	-
1	01	00101	RBIT (vector)	-
1	1x	00101	UNALLOCATED	-
1	1x	01100	FCMGE (zero)	-
1	1x	01101	FCMLE (zero)	-
1	1x	01110	UNALLOCATED	-
1	1x	01111	FNEG (vector)	-

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
1	1x	11000	UNALLOCATED	-
1	1x	11001	FRINTI (vector)	-
1	1x	11010	FCVTPU (vector)	-
1	1x	11011	FCVTZU (vector, integer)	-
1	1x	11100	URSQRTE	-
1	1x	11101	FRSQRTE	-
1	1x	11111	FSQRT (vector)	-
1	10	10110	UNALLOCATED	-

Advanced SIMD across lanes

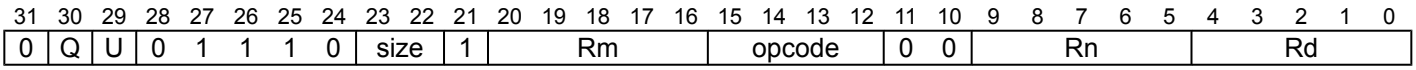
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	U	0	1	1	1	0	size		1	1	0	0	0	opcode					1	0	Rn					Rd				

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
		0000x	UNALLOCATED	-
		00010	UNALLOCATED	-
		001xx	UNALLOCATED	-
		0100x	UNALLOCATED	-
		01011	UNALLOCATED	-
		01101	UNALLOCATED	-
		01110	UNALLOCATED	-
		10xxx	UNALLOCATED	-
		1100x	UNALLOCATED	-
		111xx	UNALLOCATED	-
0		00011	SADDLV	-
0		01010	SMAXV	-
0		11010	SMINV	-
0		11011	ADDV	-
0	00	01100	FMAXNMV — half-precision	Armv8.2
0	00	01111	FMAXV — half-precision	Armv8.2
0	01	01100	UNALLOCATED	-
0	01	01111	UNALLOCATED	-
0	10	01100	FMINNMV — half-precision	Armv8.2
0	10	01111	FMINV — half-precision	Armv8.2
0	11	01100	UNALLOCATED	-
0	11	01111	UNALLOCATED	-
1		00011	UADDLV	-
1		01010	UMAXV	-
1		11010	UMINV	-
1		11011	UNALLOCATED	-
1	0x	01100	FMAXNMV — single-precision and double-precision	-
1	0x	01111	FMAXV — single-precision and double-precision	-
1	1x	01100	FMINNMV — single-precision and double-precision	-
1	1x	01111	FMINV — single-precision and double-precision	-

Advanced SIMD three different

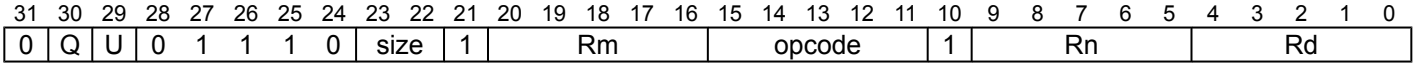
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields U	opcode	Instruction Details
	1111	UNALLOCATED
0	0000	SADDL, SADDL2
0	0001	SADDW, SADDW2
0	0010	SSUBL, SSUBL2
0	0011	SSUBW, SSUBW2
0	0100	ADDHN, ADDHN2
0	0101	SABAL, SABAL2
0	0110	SUBHN, SUBHN2
0	0111	SABDL, SABDL2
0	1000	SMLAL, SMLAL2 (vector)
0	1001	SQDMLAL, SQDMLAL2 (vector)
0	1010	SMLSL, SMLSL2 (vector)
0	1011	SQDMLSL, SQDMLSL2 (vector)
0	1100	SMULL, SMULL2 (vector)
0	1101	SQDMULL, SQDMULL2 (vector)
0	1110	PMULL, PMULL2
1	0000	UADDL, UADDL2
1	0001	UADDW, UADDW2
1	0010	USUBL, USUBL2
1	0011	USUBW, USUBW2
1	0100	RADDHN, RADDHN2
1	0101	UABAL, UABAL2
1	0110	RSUBHN, RSUBHN2
1	0111	UABDL, UABDL2
1	1000	UMLAL, UMLAL2 (vector)
1	1001	UNALLOCATED
1	1010	UMLSL, UMLSL2 (vector)
1	1011	UNALLOCATED
1	1100	UMULL, UMULL2 (vector)
1	1101	UNALLOCATED
1	1110	UNALLOCATED

Advanced SIMD three same

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields U	size	opcode	Instruction Details	Architecture Version
0		00000	SHADD	-
0		00001	SQADD	-
0		00010	SRHADD	-

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
0		00100	SHSUB	-
0		00101	SQSUB	-
0		00110	CMGT (register)	-
0		00111	CMGE (register)	-
0		01000	SSHL	-
0		01001	SQSHL (register)	-
0		01010	SRSHL	-
0		01011	SQRSHL	-
0		01100	SMAX	-
0		01101	SMIN	-
0		01110	SABD	-
0		01111	SABA	-
0		10000	ADD (vector)	-
0		10001	CMTST	-
0		10010	MLA (vector)	-
0		10011	MUL (vector)	-
0		10100	SMAXP	-
0		10101	SMINP	-
0		10110	SQDMULH (vector)	-
0		10111	ADDP (vector)	-
0	0x	11000	FMAXNM (vector)	-
0	0x	11001	FMLA (vector)	-
0	0x	11010	FADD (vector)	-
0	0x	11011	FMULX	-
0	0x	11100	FCMEQ (register)	-
0	0x	11110	FMAX (vector)	-
0	0x	11111	FRECPS	-
0	00	00011	AND (vector)	-
0	00	11101	FMLAL, FMLAL2 (vector) — FMLAL	Armv8.2
0	01	00011	BIC (vector, register)	-
0	01	11101	UNALLOCATED	-
0	1x	11000	FMINNM (vector)	-
0	1x	11001	FMLS (vector)	-
0	1x	11010	FSUB (vector)	-
0	1x	11011	UNALLOCATED	-
0	1x	11100	UNALLOCATED	-
0	1x	11110	FMIN (vector)	-
0	1x	11111	FRSQRTS	-
0	10	00011	ORR (vector, register)	-
0	10	11101	FMLSL, FMLSL2 (vector) — FMLSL	Armv8.2
0	11	00011	ORN (vector)	-
0	11	11101	UNALLOCATED	-
1		00000	UHADD	-
1		00001	UQADD	-
1		00010	URHADD	-
1		00100	UHSUB	-
1		00101	UQSUB	-

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
1		00110	CMHI (register)	-
1		00111	CMHS (register)	-
1		01000	USHL	-
1		01001	UQSHL (register)	-
1		01010	URSHL	-
1		01011	UQRSHL	-
1		01100	UMAX	-
1		01101	UMIN	-
1		01110	UABD	-
1		01111	UABA	-
1		10000	SUB (vector)	-
1		10001	CMEQ (register)	-
1		10010	MLS (vector)	-
1		10011	PMUL	-
1		10100	UMAXP	-
1		10101	UMINP	-
1		10110	SQRDMULH (vector)	-
1		10111	UNALLOCATED	-
1	0x	11000	FMAXNMP (vector)	-
1	0x	11010	FADDP (vector)	-
1	0x	11011	FMUL (vector)	-
1	0x	11100	FCMGE (register)	-
1	0x	11101	FACGE	-
1	0x	11110	FMAXP (vector)	-
1	0x	11111	FDIV (vector)	-
1	00	00011	EOR (vector)	-
1	00	11001	FMLAL, FMLAL2 (vector) — FMLAL2	Armv8.2
1	01	00011	BSL	-
1	01	11001	UNALLOCATED	-
1	1x	11000	FMINNMP (vector)	-
1	1x	11010	FABD	-
1	1x	11011	UNALLOCATED	-
1	1x	11100	FCMGT (register)	-
1	1x	11101	FACGT	-
1	1x	11110	FMINP (vector)	-
1	1x	11111	UNALLOCATED	-
1	10	00011	BIT	-
1	10	11001	FMLSL, FMLSL2 (vector) — FMLSL2	Armv8.2
1	11	00011	BIF	-
1	11	11001	UNALLOCATED	-

Advanced SIMD modified immediate

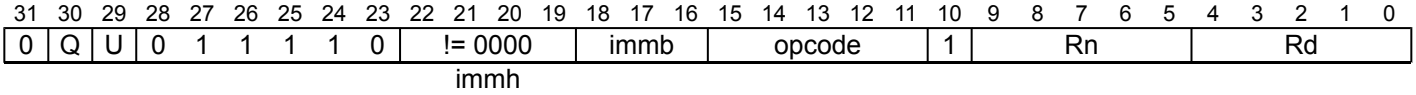
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	Q	op	0	1	1	1	1	0	0	0	0	0	a	b	c	cmode				o2	1	d	e	f	g	h	Rd				

Decode fields				Instruction Details	Architecture Version
Q	op	cmode	o2		
	0	0xxx	1	UNALLOCATED	-
	0	0xx0	0	MOVI — 32-bit shifted immediate	-
	0	0xx1	0	ORR (vector, immediate) — 32-bit	-
	0	10xx	1	UNALLOCATED	-
	0	10x0	0	MOVI — 16-bit shifted immediate	-
	0	10x1	0	ORR (vector, immediate) — 16-bit	-
	0	110x	0	MOVI — 32-bit shifting ones	-
	0	110x	1	UNALLOCATED	-
	0	1110	0	MOVI — 8-bit	-
	0	1110	1	UNALLOCATED	-
	0	1111	0	FMOV (vector, immediate) — single-precision	-
	0	1111	1	FMOV (vector, immediate) — half-precision	Armv8.2
	1		1	UNALLOCATED	-
	1	0xx0	0	MVNI — 32-bit shifted immediate	-
	1	0xx1	0	BIC (vector, immediate) — 32-bit	-
	1	10x0	0	MVNI — 16-bit shifted immediate	-
	1	10x1	0	BIC (vector, immediate) — 16-bit	-
	1	110x	0	MVNI — 32-bit shifting ones	-
0	1	1110	0	MOVI — 64-bit scalar	-
0	1	1111	0	UNALLOCATED	-
1	1	1110	0	MOVI — 64-bit vector	-
1	1	1111	0	FMOV (vector, immediate) — double-precision	-

Advanced SIMD shift by immediate

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



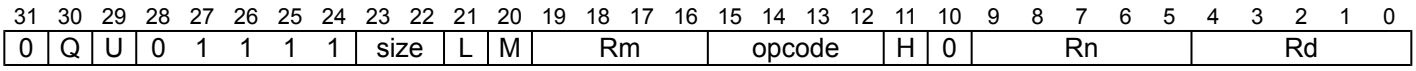
The following constraints also apply to this encoding: immh != 0000 && immh != 0000

Decode fields		Instruction Details
U	opcode	
	00001	UNALLOCATED
	00011	UNALLOCATED
	00101	UNALLOCATED
	00111	UNALLOCATED
	01001	UNALLOCATED
	01011	UNALLOCATED
	01101	UNALLOCATED
	01111	UNALLOCATED
	10101	UNALLOCATED
	1011x	UNALLOCATED
	110xx	UNALLOCATED
	11101	UNALLOCATED
	11110	UNALLOCATED
0	00000	SSHR

Decode fields U	opcode	Instruction Details
0	00010	SSRA
0	00100	SRSHR
0	00110	SRSRA
0	01000	UNALLOCATED
0	01010	SHL
0	01100	UNALLOCATED
0	01110	SQSHL (immediate)
0	10000	SHRN, SHRN2
0	10001	RSHRN, RSHRN2
0	10010	SQSHRN, SQSHRN2
0	10011	SQRSHRN, SQRSHRN2
0	10100	SSHLL, SSHLL2
0	11100	SCVTF (vector, fixed-point)
0	11111	FCVTZS (vector, fixed-point)
1	00000	USHR
1	00010	USRA
1	00100	URSHR
1	00110	URSRA
1	01000	SRI
1	01010	SLI
1	01100	SQSHLU
1	01110	UQSHL (immediate)
1	10000	SQSHRUN, SQSHRUN2
1	10001	SQRSHRUN, SQRSHRUN2
1	10010	UQSHRN, UQSHRN2
1	10011	UQRSHRN, UQRSHRN2
1	10100	USHLL, USHLL2
1	11100	UCVTF (vector, fixed-point)
1	11111	FCVTZU (vector, fixed-point)

Advanced SIMD vector x indexed element

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

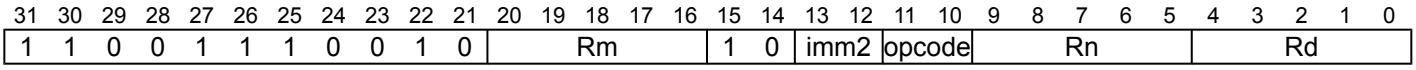


Decode fields U	size	opcode	Instruction Details	Architecture Version
	01	1001	UNALLOCATED	-
0		0010	SMLAL, SMLAL2 (by element)	-
0		0011	SQDMLAL, SQDMLAL2 (by element)	-
0		0110	SMLSL, SMLSL2 (by element)	-
0		0111	SQDMLSL, SQDMLSL2 (by element)	-
0		1000	MUL (by element)	-
0		1010	SMULL, SMULL2 (by element)	-
0		1011	SQDMULL, SQDMULL2 (by element)	-
0		1100	SQDMULH (by element)	-
0		1101	SQRDMULH (by element)	-

Decode fields			Instruction Details	Architecture Version
U	size	opcode		
0		1110	SDOT (by element)	Armv8.2
0	0x	0000	UNALLOCATED	-
0	0x	0100	UNALLOCATED	-
0	00	0001	FMLA (by element) — half-precision	Armv8.2
0	00	0101	FMLS (by element) — half-precision	Armv8.2
0	00	1001	FMUL (by element) — half-precision	Armv8.2
0	00	1111	UNALLOCATED	-
0	01	0001	UNALLOCATED	-
0	01	0101	UNALLOCATED	-
0	1x	0001	FMLA (by element) — single-precision and double-precision	-
0	1x	0101	FMLS (by element) — single-precision and double-precision	-
0	1x	1001	FMUL (by element) — single-precision and double-precision	-
0	10	0000	FMLAL, FMLAL2 (by element) — FMLAL	Armv8.2
0	10	0100	FMLSL, FMLSL2 (by element) — FMLSL	Armv8.2
0	10	1111	UNALLOCATED	-
0	11	0000	UNALLOCATED	-
0	11	0100	UNALLOCATED	-
1		0000	MLA (by element)	-
1		0010	UMLAL, UMLAL2 (by element)	-
1		0100	MLS (by element)	-
1		0110	UMLSL, UMLSL2 (by element)	-
1		1010	UMULL, UMULL2 (by element)	-
1		1011	UNALLOCATED	-
1		1101	SQRDMLAH (by element)	Armv8.1
1		1110	UDOT (by element)	Armv8.2
1		1111	SQRDMLSH (by element)	Armv8.1
1	0x	1000	UNALLOCATED	-
1	0x	1100	UNALLOCATED	-
1	00	0001	UNALLOCATED	-
1	00	0011	UNALLOCATED	-
1	00	0101	UNALLOCATED	-
1	00	0111	UNALLOCATED	-
1	00	1001	FMULX (by element) — half-precision	Armv8.2
1	01	0xx1	FCMLA (by element)	Armv8.3
1	1x	1001	FMULX (by element) — single-precision and double-precision	-
1	10	0xx1	FCMLA (by element)	Armv8.3
1	10	1000	FMLAL, FMLAL2 (by element) — FMLAL2	Armv8.2
1	10	1100	FMLSL, FMLSL2 (by element) — FMLSL2	Armv8.2
1	11	0001	UNALLOCATED	-
1	11	0011	UNALLOCATED	-
1	11	0101	UNALLOCATED	-
1	11	0111	UNALLOCATED	-
1	11	1000	UNALLOCATED	-
1	11	1100	UNALLOCATED	-

Cryptographic three-register, imm2

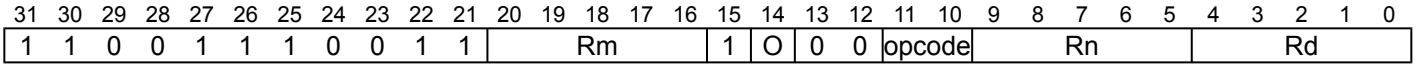
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields opcode	Instruction Details	Architecture Version
00	SM3TT1A	Armv8.2
01	SM3TT1B	Armv8.2
10	SM3TT2A	Armv8.2
11	SM3TT2B	Armv8.2

Cryptographic three-register SHA 512

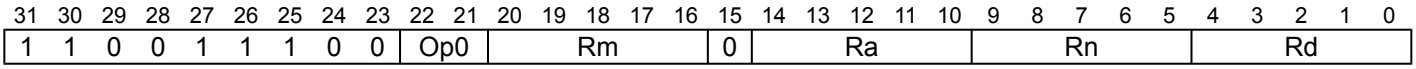
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields O	opcode	Instruction Details	Architecture Version
0	00	SHA512H	Armv8.2
0	01	SHA512H2	Armv8.2
0	10	SHA512SU1	Armv8.2
0	11	RAX1	Armv8.2
1	00	SM3PARTW1	Armv8.2
1	01	SM3PARTW2	Armv8.2
1	10	SM4EKEY	Armv8.2
1	11	UNALLOCATED	-

Cryptographic four-register

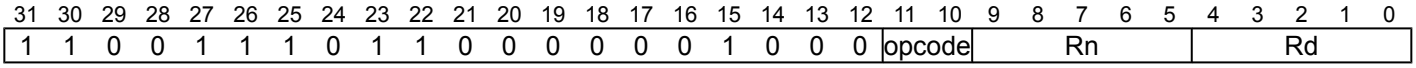
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields Op0	Instruction Details	Architecture Version
00	EOR3	Armv8.2
01	BCAX	Armv8.2
10	SM3SS1	Armv8.2
11	UNALLOCATED	-

Cryptographic two-register SHA 512

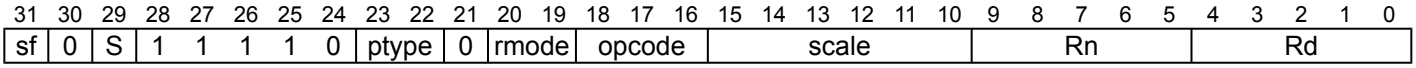
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields opcode	Instruction Details	Architecture Version
00	SHA512SU0	Armv8.2
01	SM4E	Armv8.2
1x	UNALLOCATED	-

Conversion between floating-point and fixed-point

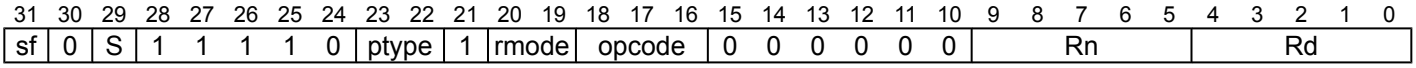
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields						Instruction Details	Architecture Version
sf	S	ptype	rmode	opcode	scale		
				1xx		UNALLOCATED	-
			x0	00x		UNALLOCATED	-
			x1	01x		UNALLOCATED	-
			0x	00x		UNALLOCATED	-
			1x	01x		UNALLOCATED	-
		10				UNALLOCATED	-
	1					UNALLOCATED	-
0					0xxxxx	UNALLOCATED	-
0	0	00	00	010		SCVTF (scalar, fixed-point) — 32-bit to single-precision	-
0	0	00	00	011		UCVTF (scalar, fixed-point) — 32-bit to single-precision	-
0	0	00	11	000		FCVTZS (scalar, fixed-point) — single-precision to 32-bit	-
0	0	00	11	001		FCVTZU (scalar, fixed-point) — single-precision to 32-bit	-
0	0	01	00	010		SCVTF (scalar, fixed-point) — 32-bit to double-precision	-
0	0	01	00	011		UCVTF (scalar, fixed-point) — 32-bit to double-precision	-
0	0	01	11	000		FCVTZS (scalar, fixed-point) — double-precision to 32-bit	-
0	0	01	11	001		FCVTZU (scalar, fixed-point) — double-precision to 32-bit	-
0	0	11	00	010		SCVTF (scalar, fixed-point) — 32-bit to half-precision	Armv8.2
0	0	11	00	011		UCVTF (scalar, fixed-point) — 32-bit to half-precision	Armv8.2
0	0	11	11	000		FCVTZS (scalar, fixed-point) — half-precision to 32-bit	Armv8.2
0	0	11	11	001		FCVTZU (scalar, fixed-point) — half-precision to 32-bit	Armv8.2
1	0	00	00	010		SCVTF (scalar, fixed-point) — 64-bit to single-precision	-
1	0	00	00	011		UCVTF (scalar, fixed-point) — 64-bit to single-precision	-
1	0	00	11	000		FCVTZS (scalar, fixed-point) — single-precision to 64-bit	-
1	0	00	11	001		FCVTZU (scalar, fixed-point) — single-precision to 64-bit	-
1	0	01	00	010		SCVTF (scalar, fixed-point) — 64-bit to double-precision	-
1	0	01	00	011		UCVTF (scalar, fixed-point) — 64-bit to double-precision	-
1	0	01	11	000		FCVTZS (scalar, fixed-point) — double-precision to 64-bit	-
1	0	01	11	001		FCVTZU (scalar, fixed-point) — double-precision to 64-bit	-
1	0	11	00	010		SCVTF (scalar, fixed-point) — 64-bit to half-precision	Armv8.2
1	0	11	00	011		UCVTF (scalar, fixed-point) — 64-bit to half-precision	Armv8.2
1	0	11	11	000		FCVTZS (scalar, fixed-point) — half-precision to 64-bit	Armv8.2
1	0	11	11	001		FCVTZU (scalar, fixed-point) — half-precision to 64-bit	Armv8.2

Conversion between floating-point and integer

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



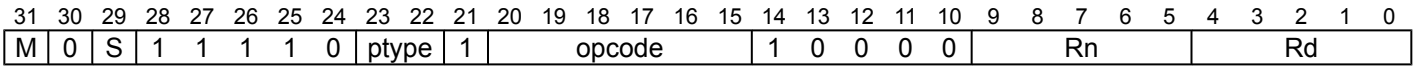
Decode fields					Instruction Details	Architecture Version
sf	S	ptype	rmode	opcode		
			x1	01x	UNALLOCATED	-
			x1	10x	UNALLOCATED	-
			1x	01x	UNALLOCATED	-
			1x	10x	UNALLOCATED	-
	0	10		0xx	UNALLOCATED	-
	0	10		10x	UNALLOCATED	-
	1				UNALLOCATED	-
0	0	00	x1	11x	UNALLOCATED	-
0	0	00	00	000	FCVTNS (scalar) — single-precision to 32-bit	-
0	0	00	00	001	FCVTNU (scalar) — single-precision to 32-bit	-
0	0	00	00	010	SCVTF (scalar, integer) — 32-bit to single-precision	-
0	0	00	00	011	UCVTF (scalar, integer) — 32-bit to single-precision	-
0	0	00	00	100	FCVTAS (scalar) — single-precision to 32-bit	-
0	0	00	00	101	FCVTAU (scalar) — single-precision to 32-bit	-
0	0	00	00	110	FMOV (general) — single-precision to 32-bit	-
0	0	00	00	111	FMOV (general) — 32-bit to single-precision	-
0	0	00	01	000	FCVTPS (scalar) — single-precision to 32-bit	-
0	0	00	01	001	FCVTPU (scalar) — single-precision to 32-bit	-
0	0	00	1x	11x	UNALLOCATED	-
0	0	00	10	000	FCVTMS (scalar) — single-precision to 32-bit	-
0	0	00	10	001	FCVTMU (scalar) — single-precision to 32-bit	-
0	0	00	11	000	FCVTZS (scalar, integer) — single-precision to 32-bit	-
0	0	00	11	001	FCVTZU (scalar, integer) — single-precision to 32-bit	-
0	0	01	0x	11x	UNALLOCATED	-
0	0	01	00	000	FCVTNS (scalar) — double-precision to 32-bit	-
0	0	01	00	001	FCVTNU (scalar) — double-precision to 32-bit	-
0	0	01	00	010	SCVTF (scalar, integer) — 32-bit to double-precision	-
0	0	01	00	011	UCVTF (scalar, integer) — 32-bit to double-precision	-
0	0	01	00	100	FCVTAS (scalar) — double-precision to 32-bit	-
0	0	01	00	101	FCVTAU (scalar) — double-precision to 32-bit	-
0	0	01	01	000	FCVTPS (scalar) — double-precision to 32-bit	-
0	0	01	01	001	FCVTPU (scalar) — double-precision to 32-bit	-
0	0	01	10	000	FCVTMS (scalar) — double-precision to 32-bit	-
0	0	01	10	001	FCVTMU (scalar) — double-precision to 32-bit	-
0	0	01	10	11x	UNALLOCATED	-
0	0	01	11	000	FCVTZS (scalar, integer) — double-precision to 32-bit	-
0	0	01	11	001	FCVTZU (scalar, integer) — double-precision to 32-bit	-
0	0	01	11	110	FJCVTZS	Armv8.3
0	0	01	11	111	UNALLOCATED	-
0	0	10		11x	UNALLOCATED	-
0	0	11	00	000	FCVTNS (scalar) — half-precision to 32-bit	Armv8.2

Decode fields					Instruction Details	Architecture Version
sf	S	ptype	rmode	opcode		
0	0	11	00	001	FCVTNU (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	00	010	SCVTF (scalar, integer) — 32-bit to half-precision	Armv8.2
0	0	11	00	011	UCVTF (scalar, integer) — 32-bit to half-precision	Armv8.2
0	0	11	00	100	FCVTAS (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	00	101	FCVTAU (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	00	110	FMOV (general) — half-precision to 32-bit	Armv8.2
0	0	11	00	111	FMOV (general) — 32-bit to half-precision	Armv8.2
0	0	11	01	000	FCVTPS (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	01	001	FCVTPU (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	10	000	FCVTMS (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	10	001	FCVTMU (scalar) — half-precision to 32-bit	Armv8.2
0	0	11	11	000	FCVTZS (scalar, integer) — half-precision to 32-bit	Armv8.2
0	0	11	11	001	FCVTZU (scalar, integer) — half-precision to 32-bit	Armv8.2
1	0	00		11x	UNALLOCATED	-
1	0	00	00	000	FCVTNS (scalar) — single-precision to 64-bit	-
1	0	00	00	001	FCVTNU (scalar) — single-precision to 64-bit	-
1	0	00	00	010	SCVTF (scalar, integer) — 64-bit to single-precision	-
1	0	00	00	011	UCVTF (scalar, integer) — 64-bit to single-precision	-
1	0	00	00	100	FCVTAS (scalar) — single-precision to 64-bit	-
1	0	00	00	101	FCVTAU (scalar) — single-precision to 64-bit	-
1	0	00	01	000	FCVTPS (scalar) — single-precision to 64-bit	-
1	0	00	01	001	FCVTPU (scalar) — single-precision to 64-bit	-
1	0	00	10	000	FCVTMS (scalar) — single-precision to 64-bit	-
1	0	00	10	001	FCVTMU (scalar) — single-precision to 64-bit	-
1	0	00	11	000	FCVTZS (scalar, integer) — single-precision to 64-bit	-
1	0	00	11	001	FCVTZU (scalar, integer) — single-precision to 64-bit	-
1	0	01	x1	11x	UNALLOCATED	-
1	0	01	00	000	FCVTNS (scalar) — double-precision to 64-bit	-
1	0	01	00	001	FCVTNU (scalar) — double-precision to 64-bit	-
1	0	01	00	010	SCVTF (scalar, integer) — 64-bit to double-precision	-
1	0	01	00	011	UCVTF (scalar, integer) — 64-bit to double-precision	-
1	0	01	00	100	FCVTAS (scalar) — double-precision to 64-bit	-
1	0	01	00	101	FCVTAU (scalar) — double-precision to 64-bit	-
1	0	01	00	110	FMOV (general) — double-precision to 64-bit	-
1	0	01	00	111	FMOV (general) — 64-bit to double-precision	-
1	0	01	01	000	FCVTPS (scalar) — double-precision to 64-bit	-
1	0	01	01	001	FCVTPU (scalar) — double-precision to 64-bit	-
1	0	01	1x	11x	UNALLOCATED	-
1	0	01	10	000	FCVTMS (scalar) — double-precision to 64-bit	-
1	0	01	10	001	FCVTMU (scalar) — double-precision to 64-bit	-
1	0	01	11	000	FCVTZS (scalar, integer) — double-precision to 64-bit	-
1	0	01	11	001	FCVTZU (scalar, integer) — double-precision to 64-bit	-
1	0	10	x0	11x	UNALLOCATED	-
1	0	10	01	110	FMOV (general) — top half of 128-bit to 64-bit	-
1	0	10	01	111	FMOV (general) — 64-bit to top half of 128-bit	-
1	0	10	1x	11x	UNALLOCATED	-
1	0	11	00	000	FCVTNS (scalar) — half-precision to 64-bit	Armv8.2

Decode fields					Instruction Details	Architecture Version
sf	S	ptype	rmode	opcode		
1	0	11	00	001	FCVTNU (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	00	010	SCVTF (scalar, integer) — 64-bit to half-precision	Armv8.2
1	0	11	00	011	UCVTF (scalar, integer) — 64-bit to half-precision	Armv8.2
1	0	11	00	100	FCVTAS (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	00	101	FCVTAU (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	00	110	FMOV (general) — half-precision to 64-bit	Armv8.2
1	0	11	00	111	FMOV (general) — 64-bit to half-precision	Armv8.2
1	0	11	01	000	FCVTPS (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	01	001	FCVTPU (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	10	000	FCVTMS (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	10	001	FCVTMU (scalar) — half-precision to 64-bit	Armv8.2
1	0	11	11	000	FCVTZS (scalar, integer) — half-precision to 64-bit	Armv8.2
1	0	11	11	001	FCVTZU (scalar, integer) — half-precision to 64-bit	Armv8.2

Floating-point data-processing (1 source)

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields				Instruction Details	Architecture Version
M	S	ptype	opcode		
			1xxxxx	UNALLOCATED	-
	1			UNALLOCATED	-
0	0	00	000000	FMOV (register) — single-precision	-
0	0	00	000001	FABS (scalar) — single-precision	-
0	0	00	000010	FNEG (scalar) — single-precision	-
0	0	00	000011	FSQRT (scalar) — single-precision	-
0	0	00	000100	UNALLOCATED	-
0	0	00	000101	FCVT — single-precision to double-precision	-
0	0	00	000110	UNALLOCATED	-
0	0	00	000111	FCVT — single-precision to half-precision	-
0	0	00	001000	FRINTN (scalar) — single-precision	-
0	0	00	001001	FRINTP (scalar) — single-precision	-
0	0	00	001010	FRINTM (scalar) — single-precision	-
0	0	00	001011	FRINTZ (scalar) — single-precision	-
0	0	00	001100	FRINTA (scalar) — single-precision	-
0	0	00	001101	UNALLOCATED	-
0	0	00	001110	FRINTX (scalar) — single-precision	-
0	0	00	001111	FRINTI (scalar) — single-precision	-
0	0	00	010000	FRINT32Z (scalar) — single-precision	Armv8.5
0	0	00	010001	FRINT32X (scalar) — single-precision	Armv8.5
0	0	00	010010	FRINT64Z (scalar) — single-precision	Armv8.5
0	0	00	010011	FRINT64X (scalar) — single-precision	Armv8.5
0	0	00	0101xx	UNALLOCATED	-
0	0	00	011xxx	UNALLOCATED	-
0	0	01	000000	FMOV (register) — double-precision	-
0	0	01	000001	FABS (scalar) — double-precision	-

Decode fields				Instruction Details	Architecture Version
M	S	ptype	opcode		
0	0	01	000010	FNEG (scalar) — double-precision	-
0	0	01	000011	FSQRT (scalar) — double-precision	-
0	0	01	000100	FCVT — double-precision to single-precision	-
0	0	01	000101	UNALLOCATED	-
0	0	01	000111	FCVT — double-precision to half-precision	-
0	0	01	001000	FRINTN (scalar) — double-precision	-
0	0	01	001001	FRINTP (scalar) — double-precision	-
0	0	01	001010	FRINTM (scalar) — double-precision	-
0	0	01	001011	FRINTZ (scalar) — double-precision	-
0	0	01	001100	FRINTA (scalar) — double-precision	-
0	0	01	001101	UNALLOCATED	-
0	0	01	001110	FRINTX (scalar) — double-precision	-
0	0	01	001111	FRINTI (scalar) — double-precision	-
0	0	01	010000	FRINT32Z (scalar) — double-precision	Armv8.5
0	0	01	010001	FRINT32X (scalar) — double-precision	Armv8.5
0	0	01	010010	FRINT64Z (scalar) — double-precision	Armv8.5
0	0	01	010011	FRINT64X (scalar) — double-precision	Armv8.5
0	0	01	0101xx	UNALLOCATED	-
0	0	01	011xxx	UNALLOCATED	-
0	0	10	0xxxxx	UNALLOCATED	-
0	0	11	000000	FMOV (register) — half-precision	Armv8.2
0	0	11	000001	FABS (scalar) — half-precision	Armv8.2
0	0	11	000010	FNEG (scalar) — half-precision	Armv8.2
0	0	11	000011	FSQRT (scalar) — half-precision	Armv8.2
0	0	11	000100	FCVT — half-precision to single-precision	-
0	0	11	000101	FCVT — half-precision to double-precision	-
0	0	11	00011x	UNALLOCATED	-
0	0	11	001000	FRINTN (scalar) — half-precision	Armv8.2
0	0	11	001001	FRINTP (scalar) — half-precision	Armv8.2
0	0	11	001010	FRINTM (scalar) — half-precision	Armv8.2
0	0	11	001011	FRINTZ (scalar) — half-precision	Armv8.2
0	0	11	001100	FRINTA (scalar) — half-precision	Armv8.2
0	0	11	001101	UNALLOCATED	-
0	0	11	001110	FRINTX (scalar) — half-precision	Armv8.2
0	0	11	001111	FRINTI (scalar) — half-precision	Armv8.2
0	0	11	01xxxx	UNALLOCATED	-
1				UNALLOCATED	-

Floating-point compare

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

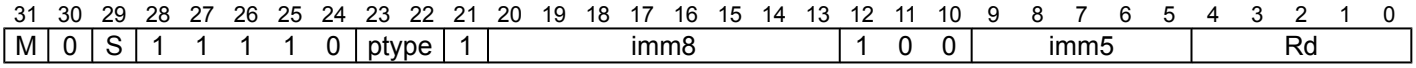
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
M	0	S	1	1	1	1	0	ptype		1	Rm					op		1	0	0	0	Rn					opcode2				

Decode fields					Instruction Details	Architecture Version
M	S	ptype	op	opcode2		
				xxxx1	UNALLOCATED	-
				xxx1x	UNALLOCATED	-

M	S	Decode fields ptype	op	opcode2	Instruction Details	Architecture Version
				xx1xx	UNALLOCATED	-
			x1		UNALLOCATED	-
			1x		UNALLOCATED	-
		10			UNALLOCATED	-
	1				UNALLOCATED	-
0	0	00	00	00000	FCMP	-
0	0	00	00	01000	FCMP	-
0	0	00	00	10000	FCMPE	-
0	0	00	00	11000	FCMPE	-
0	0	01	00	00000	FCMP	-
0	0	01	00	01000	FCMP	-
0	0	01	00	10000	FCMPE	-
0	0	01	00	11000	FCMPE	-
0	0	11	00	00000	FCMP	Armv8.2
0	0	11	00	01000	FCMP	Armv8.2
0	0	11	00	10000	FCMPE	Armv8.2
0	0	11	00	11000	FCMPE	Armv8.2
1					UNALLOCATED	-

Floating-point immediate

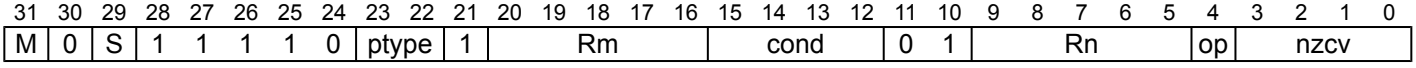
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



M	S	Decode fields ptype	imm5	Instruction Details	Architecture Version
			xxxx1	UNALLOCATED	-
			xxx1x	UNALLOCATED	-
			xx1xx	UNALLOCATED	-
			x1xxx	UNALLOCATED	-
			1xxxx	UNALLOCATED	-
		10		UNALLOCATED	-
	1			UNALLOCATED	-
0	0	00	00000	FMOV (scalar, immediate) — single-precision	-
0	0	01	00000	FMOV (scalar, immediate) — double-precision	-
0	0	11	00000	FMOV (scalar, immediate) — half-precision	Armv8.2
1				UNALLOCATED	-

Floating-point conditional compare

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



M	S	Decode fields ptype	op	Instruction Details	Architecture Version
		10		UNALLOCATED	-

Decode fields				Instruction Details	Architecture Version
M	S	ptype	op		
	1			UNALLOCATED	-
0	0	00	0	FCCMP — single-precision	-
0	0	00	1	FCCMPE — single-precision	-
0	0	01	0	FCCMP — double-precision	-
0	0	01	1	FCCMPE — double-precision	-
0	0	11	0	FCCMP — half-precision	Armv8.2
0	0	11	1	FCCMPE — half-precision	Armv8.2
1				UNALLOCATED	-

Floating-point data-processing (2 source)

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.

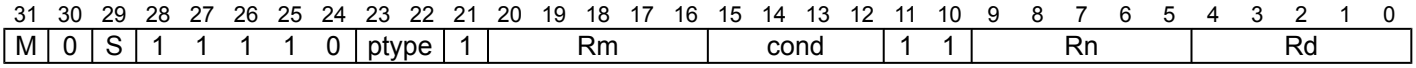
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
M	0	S	1	1	1	1	0	ptype		1	Rm					opcode				1	0	Rn					Rd				

Decode fields				Instruction Details	Architecture Version
M	S	ptype	opcode		
			1xx1	UNALLOCATED	-
			1x1x	UNALLOCATED	-
			11xx	UNALLOCATED	-
		10		UNALLOCATED	-
	1			UNALLOCATED	-
0	0	00	0000	FMUL (scalar) — single-precision	-
0	0	00	0001	FDIV (scalar) — single-precision	-
0	0	00	0010	FADD (scalar) — single-precision	-
0	0	00	0011	FSUB (scalar) — single-precision	-
0	0	00	0100	FMAX (scalar) — single-precision	-
0	0	00	0101	FMIN (scalar) — single-precision	-
0	0	00	0110	FMAXNM (scalar) — single-precision	-
0	0	00	0111	FMINNM (scalar) — single-precision	-
0	0	00	1000	FNMUL (scalar) — single-precision	-
0	0	01	0000	FMUL (scalar) — double-precision	-
0	0	01	0001	FDIV (scalar) — double-precision	-
0	0	01	0010	FADD (scalar) — double-precision	-
0	0	01	0011	FSUB (scalar) — double-precision	-
0	0	01	0100	FMAX (scalar) — double-precision	-
0	0	01	0101	FMIN (scalar) — double-precision	-
0	0	01	0110	FMAXNM (scalar) — double-precision	-
0	0	01	0111	FMINNM (scalar) — double-precision	-
0	0	01	1000	FNMUL (scalar) — double-precision	-
0	0	11	0000	FMUL (scalar) — half-precision	Armv8.2
0	0	11	0001	FDIV (scalar) — half-precision	Armv8.2
0	0	11	0010	FADD (scalar) — half-precision	Armv8.2
0	0	11	0011	FSUB (scalar) — half-precision	Armv8.2
0	0	11	0100	FMAX (scalar) — half-precision	Armv8.2
0	0	11	0101	FMIN (scalar) — half-precision	Armv8.2
0	0	11	0110	FMAXNM (scalar) — half-precision	Armv8.2
0	0	11	0111	FMINNM (scalar) — half-precision	Armv8.2

Decode fields M	S	ptype	opcode	Instruction Details	Architecture Version
0	0	11	1000	FNMUL (scalar) — half-precision	Armv8.2
1				UNALLOCATED	-

Floating-point conditional select

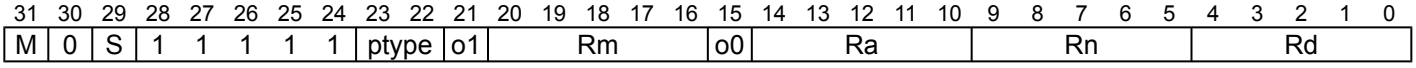
These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields M	S	ptype	Instruction Details	Architecture Version
		10	UNALLOCATED	-
	1		UNALLOCATED	-
0	0	00	FCSEL — single-precision	-
0	0	01	FCSEL — double-precision	-
0	0	11	FCSEL — half-precision	Armv8.2
1			UNALLOCATED	-

Floating-point data-processing (3 source)

These instructions are under Data Processing -- Scalar Floating-Point and Advanced SIMD.



Decode fields M	S	ptype	o1	o0	Instruction Details	Architecture Version
		10			UNALLOCATED	-
	1				UNALLOCATED	-
0	0	00	0	0	FMADD — single-precision	-
0	0	00	0	1	FMSUB — single-precision	-
0	0	00	1	0	FNMADD — single-precision	-
0	0	00	1	1	FNMSUB — single-precision	-
0	0	01	0	0	FMADD — double-precision	-
0	0	01	0	1	FMSUB — double-precision	-
0	0	01	1	0	FNMADD — double-precision	-
0	0	01	1	1	FNMSUB — double-precision	-
0	0	11	0	0	FMADD — half-precision	Armv8.2
0	0	11	0	1	FMSUB — half-precision	Armv8.2
0	0	11	1	0	FNMADD — half-precision	Armv8.2
0	0	11	1	1	FNMSUB — half-precision	Armv8.2
1					UNALLOCATED	-

Internal version only: isa v30.44~~v30.42~~, AdvSIMD v27.08, pseudocode v8.5-2019-06_rc2-5-g22901f2~~future-20190403~~, sve v2019-06_rc4~~v8.5-00bet10_rc5~~ ; Build timestamp: 2019-06-26T22~~2019-04-17T09~~:04~~58~~

Shared Pseudocode Functions

This page displays common pseudocode functions shared by many pages.

Pseudocodes

Library pseudocode for aarch32/debug/VCRMatch/AArch32.VCRMatch

```
// AArch32.VCRMatch()
// ==================

boolean AArch32.VCRMatch(bits(32) vaddress)

    if UsingAArch32() && ELUsingAArch32(EL1) && IsZero(vaddress<1:0>) && PSTATE.EL != EL2 then
        // Each bit position in this string corresponds to a bit in DBGVCR and an exception vector.
        match_word = Zeros(32);

        if vaddress<31:5> == ExcVectorBase()<31:5> then
            if HaveEL(EL3) && !IsSecure() then
                match_word<UInt(vaddress<4:2>) + 24> = '1';     // Non-secure vectors
            else
                match_word<UInt(vaddress<4:2>) + 0> = '1';      // Secure vectors (or no EL3)

        if HaveEL(EL3) && ELUsingAArch32(EL3) && IsSecure() && vaddress<31:5> == MVBAR<31:5> then
            match_word<UInt(vaddress<4:2>) + 8> = '1';          // Monitor vectors

        // Mask out bits not corresponding to vectors.
        if !HaveEL(EL3) then
            mask = '00000000':'00000000':'00000000':'11011110'; // DBGVCR[31:8] are RES0
        elsif !ELUsingAArch32(EL3) then
            mask = '11011110':'00000000':'00000000':'11011110'; // DBGVCR[15:8] are RES0
        else
            mask = '11011110':'00000000':'11011100':'11011110';

        match_word = match_word AND DBGVCR AND mask;
        match = !IsZero(match_word);

        // Check for UNPREDICTABLE case - match on Prefetch Abort and Data Abort vectors
        if !IsZero(match_word<28:27,12:11,4:3>) && DebugTarget() == PSTATE.EL then
            match = ConstrainUnpredictableBool(Unpredictable_VCMATCHDAPA);
    else
        match = FALSE;

    return match;
```

Library pseudocode for aarch32/debug/authentication/AArch32.SelfHostedSecurePrivilegedInvasiveDebugEnabled

```
// AArch32.SelfHostedSecurePrivilegedInvasiveDebugEnabled()
// ========================================================

boolean AArch32.SelfHostedSecurePrivilegedInvasiveDebugEnabled()
    // The definition of this function is IMPLEMENTATION DEFINED.
    // In the recommended interface, AArch32.SelfHostedSecurePrivilegedInvasiveDebugEnabled returns
    // the state of the (DBGEN AND SPIDEN) signal.
    if !HaveEL(EL3) && !IsSecure() then return FALSE;
    return DBGEN == HIGH && SPIDEN == HIGH;
```

Library pseudocode for aarch32/debug/breakpoint/AArch32.BreakpointMatch

```
// AArch32.BreakpointMatch()
// =========================
// Breakpoint matching in an AArch32 translation regime.

(boolean,boolean) AArch32.BreakpointMatch(integer n, bits(32) vaddress,  integer size)
    assert ELUsingAArch32(S1TranslationRegime());
    assert n <= UInt(DBGDIDR.BRPs);

    enabled = DBGBCR[n].E == '1';
    ispriv = PSTATE.EL != EL0;
    linked = DBGBCR[n].BT == '0x01';
    isbreakpnt = TRUE;
    linked_to = FALSE;

    state_match = AArch32.StateMatch(DBGBCR[n].SSC, DBGBCR[n].HMC, DBGBCR[n].PMC,
                                     linked, DBGBCR[n].LBN, isbreakpnt, ispriv);
    (value_match, value_mismatch) = AArch32.BreakpointValueMatch(n, vaddress, linked_to);

    if size == 4 then                 // Check second halfword
        // If the breakpoint address and BAS of an Address breakpoint match the address of the
        // second halfword of an instruction, but not the address of the first halfword, it is
        // CONSTRAINED UNPREDICTABLE whether or not this breakpoint generates a Breakpoint debug
        // event.
        (match_i, mismatch_i) = AArch32.BreakpointValueMatch(n, vaddress + 2, linked_to);
        if !value_match && match_i then
            value_match = ConstrainUnpredictableBool(Unpredictable_BPMATCHHALF);
        if value_mismatch && !mismatch_i then
            value_mismatch = ConstrainUnpredictableBool(Unpredictable_BPMISMATCHHALF);

    if vaddress<1> == '1' && DBGBCR[n].BAS == '1111' then
        // The above notwithstanding, if DBGBCR[n].BAS == '1111', then it is CONSTRAINED
        // UNPREDICTABLE whether or not a Breakpoint debug event is generated for an instruction
        // at the address DBGBVR[n]+2.
        if value_match then value_match = ConstrainUnpredictableBool(Unpredictable_BPMATCHHALF);
        if !value_mismatch then value_mismatch = ConstrainUnpredictableBool(Unpredictable_BPMISMATCHHALF)

    match = value_match && state_match && enabled;
    mismatch = value_mismatch && state_match && enabled;

    return (match, mismatch);
```

Library pseudocode for aarch32/debug/breakpoint/AArch32.BreakpointValueMatch

```
// AArch32.BreakpointValueMatch()
// ==============================
// The first result is whether an Address Match or Context breakpoint is programmed on the
// instruction at "address". The second result is whether an Address Mismatch breakpoint is
// programmed on the instruction, that is, whether the instruction should be stepped.

(boolean,boolean) AArch32.BreakpointValueMatch(integer n, bits(32) vaddress, boolean linked_to)

    // "n" is the identity of the breakpoint unit to match against.
    // "vaddress" is the current instruction address, ignored if linked_to is TRUE and for Context
    //   matching breakpoints.
    // "linked_to" is TRUE if this is a call from StateMatch for linking.

    // If a non-existent breakpoint then it is CONSTRAINED UNPREDICTABLE whether this gives
    // no match or the breakpoint is mapped to another UNKNOWN implemented breakpoint.
    if n > UInt(DBGDIDR.BRPs) then
        (c, n) = ConstrainUnpredictableInteger(0, UInt(DBGDIDR.BRPs), Unpredictable_BPNOTIMPL);
        assert c IN {Constraint_DISABLED, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then return (FALSE,FALSE);

    // If this breakpoint is not enabled, it cannot generate a match. (This could also happen on a
    // call from StateMatch for linking).
    if DBGBCR[n].E == '0' then return (FALSE,FALSE);

    context_aware = (n >= UInt(DBGDIDR.BRPs) - UInt(DBGDIDR.CTX_CMPs));

    // If BT is set to a reserved type, behaves either as disabled or as a not-reserved type.
    dbgtype = DBGBCR[n].BT;

    if ((dbgtype IN {'011x','11xx'} && !HaveVirtHostExt()) ||              // Context matching
          (dbgtype == '010x' && HaltOnBreakpointOrWatchpoint()) ||         // Address mismatch
          (dbgtype != '0x0x' && !context_aware) ||                         // Context matching
          (dbgtype == '1xxx' && !HaveEL(EL2))) then                        // EL2 extension
        (c, dbgtype) = ConstrainUnpredictableBits(Unpredictable_RESBPTYPE);
        assert c IN {Constraint_DISABLED, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then return (FALSE,FALSE);
        // Otherwise the value returned by ConstrainUnpredictableBits must be a not-reserved value

    // Determine what to compare against.
    match_addr = (dbgtype == '0x0x');
    mismatch   = (dbgtype == '010x');
    match_vmid = (dbgtype == '10xx');
    match_cid1 = (dbgtype == 'xx1x');
    match_cid2 = (dbgtype == '11xx');
    linked     = (dbgtype == 'xxx1');

    // If this is a call from StateMatch, return FALSE if the breakpoint is not programmed for a
    // VMID and/or context ID match, of if not context-aware. The above assertions mean that the
    // code can just test for match_addr == TRUE to confirm all these things.
    if linked_to && (!linked || match_addr) then return (FALSE,FALSE);

    // If called from BreakpointMatch return FALSE for Linked context ID and/or VMID matches.
    if !linked_to && linked && !match_addr then return (FALSE,FALSE);

    // Do the comparison.
    if match_addr then
        byte = UInt(vaddress<1:0>);
        assert byte IN {0,2};                      // "vaddress" is halfword aligned
        byte_select_match = (DBGBCR[n].BAS<byte> == '1');
        BVR_match = vaddress<31:2> == DBGBVR[n]<31:2> && byte_select_match;
    elsif match_cid1 then
        BVR_match = (PSTATE.EL != EL2 && CONTEXTIDR == DBGBVR[n]<31:0>);
    if match_vmid then
        if ELUsingAArch32(EL2) then
            vmid = ZeroExtend(VTTBR.VMID, 16);
            bvr_vmid = ZeroExtend(DBGBXVR[n]<7:0>, 16);
        elsif !Have16bitVMID() || VTCR_EL2.VS == '0' then
            vmid = ZeroExtend(VTTBR_EL2.VMID<7:0>, 16);
            bvr_vmid = ZeroExtend(DBGBXVR[n]<7:0>, 16);
        else
```

```
            vmid = VTTBR_EL2.VMID;
            bvr_vmid = DBGBXVR[n]<15:0>;
        BXVR_match = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                      vmid == bvr_vmid);
    elsif match_cid2 then
        BXVR_match = (!IsSecure() && HaveVirtHostExt() &&
                      !ELUsingAArch32(EL2) &&
                      DBGBXVR[n]<31:0> == CONTEXTIDR_EL2);

    bvr_match_valid = (match_addr || match_cid1);
    bxvr_match_valid = (match_vmid || match_cid2);

    match = (!bxvr_match_valid || BXVR_match) && (!bvr_match_valid || BVR_match);

    return (match && !mismatch, !match && mismatch);
```

Library pseudocode for aarch32/debug/breakpoint/AArch32.StateMatch

```
// AArch32.StateMatch()
// ====================
// Determine whether a breakpoint or watchpoint is enabled in the current mode and state.

boolean AArch32.StateMatch(bits(2) SSC, bit HMC, bits(2) PxC, boolean linked, bits(4) LBN,
                           boolean isbreakpnt,  boolean ispriv)
    // "SSC", "HMC", "PxC" are the control fields from the DBGBCR[n] or DBGWCR[n] register.
    // "linked" is TRUE if this is a linked breakpoint/watchpoint type.
    // "LBN" is the linked breakpoint number from the DBGBCR[n] or DBGWCR[n] register.
    // "isbreakpnt" is TRUE for breakpoints, FALSE for watchpoints.
    // "ispriv" is valid for watchpoints, and selects between privileged and unprivileged accesses.

    // If parameters are set to a reserved type, behaves as either disabled or a defined type
    (c, SSC, HMC, PxC) =     if ((HMC:SSC:PxC) IN {'011xx','100x0','101x0','11010','11101','1111x'} ||
          (HMC == '0' && PxC == '00' && !isbreakpnt) ||                                  // Usr/Svc/Sys
          (SSC IN {'01','10'} && ! CheckValidStateMatchHaveEL(SSC, HMC, PxC, isbreakpnt);
    if c ==( EL3)) ||                                          // No EL3
          (HMC:SSC:PxC == '11000' && ELUsingAArch32(EL3)) ||                             // AArch64 only
          (HMC:SSC != '000' && HMC:SSC != '111' && !HaveEL(EL3) && !HaveEL(EL2)) || // No EL3/EL2
          (HMC:SSC:PxC == '11100' && !HaveEL(EL2))) then                                 // No EL2
        (c, <HMC,SSC,PxC>) = ConstrainUnpredictableBits(Unpredictable_RESBPWPCTRL);
        assert c IN {Constraint_DISABLED then return FALSE;
    // Otherwise the HMC,SSC,PxC values are either valid or the values returned by
    // CheckValidStateMatch are valid.

    PL2_match =, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then return FALSE;
        // Otherwise the value returned by ConstrainUnpredictableBits must be a not-reserved value

    PL2_match = HaveEL(EL2) && ((HMC == '1' && (SSC:PxC != '1000')) || SSC == '11');
) && HMC == '1';
    PL1_match = PxC<0> == '1';
    PL0_match = PxC<1> == '1';
    SSU_match = isbreakpnt && HMC == '0' && PxC == '00' && SSC != '11';

    el = PSTATE.EL;

    if !ispriv && !isbreakpnt then
        priv_match = PL0_match;
    elsif SSU_match then
        priv_match = PSTATE.M IN {M32_User,M32_Svc,M32_System};
    else
        case PSTATE.EL of
        case el of
            when EL3  priv_match = PL1_match;           // EL3 and EL1 are both PL1
            when EL2  priv_match = PL2_match;
            when EL1  priv_match = PL1_match;
            when EL0  priv_match = PL0_match;

    case SSC of
        when '00'  security_state_match = TRUE;                          // Both
        when '01'  security_state_match = !IsSecure();                   // Non-secure only
        when '10'  security_state_match =priv_match = PL0_match;

    case SSC of
        when '00'  security_state_match = TRUE;          // Both
        when '01'  security_state_match = ! IsSecure();                    // Secure only
        when '11'  security_state_match = (HMC == '1' ||();  // Non-secure only
        when '10'  security_state_match = IsSecure());  // HMC=1 -> Both, 0 -> Secure only
();   // Secure only
        when '11'  security_state_match = TRUE;          // Both

    if linked then
        // "LBN" must be an enabled context-aware breakpoint unit. If it is not context-aware then
        // it is CONSTRAINED UNPREDICTABLE whether this gives no match, or LBN is mapped to some
        // UNKNOWN breakpoint that is context-aware.
        lbn = UInt(LBN);
        first_ctx_cmp = (UInt(DBGDIDR.BRPs) - UInt(DBGDIDR.CTX_CMPs));
        last_ctx_cmp = UInt(DBGDIDR.BRPs);
        if (lbn < first_ctx_cmp || lbn > last_ctx_cmp) then
```

```
            (c, lbn) = ConstrainUnpredictableInteger(first_ctx_cmp, last_ctx_cmp, Unpredictable_BPNOTCTXC
            assert c IN {Constraint_DISABLED, Constraint_NONE, Constraint_UNKNOWN};
            case c of
                when Constraint_DISABLED  return FALSE;      // Disabled
                when Constraint_NONE      linked = FALSE;    // No linking
                // Otherwise ConstrainUnpredictableInteger returned a context-aware breakpoint

    if linked then
        vaddress = bits(32) UNKNOWN;
        linked_to = TRUE;
        (linked_match,-) = AArch32.BreakpointValueMatch(lbn, vaddress, linked_to);

    return priv_match && security_state_match && (!linked || linked_match);
```

Library pseudocode for aarch32/debug/breakpoint/CheckValidStateMatch

```
// CheckValidStateMatch()
// ======================
// Checks for an invalid state match that will generate Constrained Unpredictable behaviour, otherwise
// returns Constraint_NONE.

(Constraint, bits(2), bit, bits(2)) CheckValidStateMatch(bits(2) SSC, bit HMC, bits(2) PxC, boolean isbre
    boolean reserved = FALSE;

    // Match 'Usr/Sys/Svc' only valid for AArch32 breakpoints
    if (!isbreakpnt || !HaveAArch32EL(EL1)) && HMC:PxC == '000' && SSC != '11' then
        reserved = TRUE;

    // Both EL3 and EL2 are not implemented
    if !HaveEL(EL3) && !HaveEL(EL2) && (HMC != '0' || SSC != '00') then
        reserved = TRUE;

    // EL3 is not implemented
    if !HaveEL(EL3) && SSC IN {'01','10'} && HMC:SSC:PxC != '10100' then
        reserved = TRUE;

    // EL3 using AArch64 only
    if (!HaveEL(EL3) || HighestELUsingAArch32()) && HMC:SSC:PxC == '11000' then
        reserved = TRUE;

    // EL2 is not implemented
    if !HaveEL(EL2) && HMC:SSC:PxC == '11100' then
        reserved = TRUE;

    // Secure EL2 is not implemented
    if !HaveSecureEL2Ext() && (HMC:SSC:PxC)  IN {'01100','10100','x11x1'} then
        reserved = TRUE;

    // Values that are not allocated in any architecture version
    if (HMC:SSC:PxC) IN {'01110','100x0','10110','11x10'} then
        reserved = TRUE;

    if reserved then
        // If parameters are set to a reserved type, behaves as either disabled or a defined type
        (c, <HMC,SSC,PxC>) = ConstrainUnpredictableBits(Unpredictable_RESBPWPCTRL);
        assert c IN {Constraint_DISABLED, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then
            return (c, bits(2) UNKNOWN, bit UNKNOWN, bits(2) UNKNOWN);
        // Otherwise the value returned by ConstrainUnpredictableBits must be a not-reserved value

    return (Constraint_NONE, SSC, HMC, PxC);
```

Library pseudocode for aarch32/debug/enables/AArch32.GenerateDebugExceptions

```
// AArch32.GenerateDebugExceptions()
// =================================

boolean AArch32.GenerateDebugExceptions()
    return AArch32.GenerateDebugExceptionsFrom(PSTATE.EL, IsSecure());
```

Library pseudocode for aarch32/debug/enables/AArch32.GenerateDebugExceptionsFrom

```
// AArch32.GenerateDebugExceptionsFrom()
// =====================================

boolean AArch32.GenerateDebugExceptionsFrom(bits(2) from, boolean secure)

    if from == EL0 && !ELStateUsingAArch32(EL1, secure) then
        mask = bit UNKNOWN;                          // PSTATE.D mask, unused for EL0 case
        return AArch64.GenerateDebugExceptionsFrom(from, secure, mask);

    if DBGOSLSR.OSLK == '1' || DoubleLockStatus() || Halted() then
        return FALSE;

    if HaveEL(EL3) && secure then
        spd = if ELUsingAArch32(EL3) then SDCR.SPD else MDCR_EL3.SPD32;
        if spd<1> == '1' then
            enabled = spd<0> == '1';
        else
            // SPD == 0b01 is reserved, but behaves the same as 0b00.
            enabled = AArch32.SelfHostedSecurePrivilegedInvasiveDebugEnabled();
        if from == EL0 then enabled = enabled || SDER.SUIDEN == '1';
    else
        enabled = from != EL2;

    return enabled;
```

Library pseudocode for aarch32/debug/pmu/AArch32.CheckForPMUOverflow

```
// AArch32.CheckForPMUOverflow()
// =============================
// Signal Performance Monitors overflow IRQ and CTI overflow events

boolean AArch32.CheckForPMUOverflow()

    if !ELUsingAArch32(EL1) then return AArch64.CheckForPMUOverflow();
    pmuirq = PMCR.E == '1' && PMINTENSET<31> == '1' && PMOVSSET<31> == '1';
    for n = 0 to UInt(PMCR.N) - 1
        if HaveEL(EL2) then
            hpmn = if !ELUsingAArch32(EL2) then MDCR_EL2.HPMN else HDCR.HPMN;
            hpme = if !ELUsingAArch32(EL2) then MDCR_EL2.HPME else HDCR.HPME;
            E = (if n < UInt(hpmn) then PMCR.E else hpme);
        else
            E = PMCR.E;
        if E == '1' && PMINTENSET<n> == '1' && PMOVSSET<n> == '1' then pmuirq = TRUE;

    SetInterruptRequestLevel(InterruptID_PMUIRQ, if pmuirq then HIGH else LOW);

    CTI_SetEventLevel(CrossTriggerIn_PMUOverflow, if pmuirq then HIGH else LOW);

    // The request remains set until the condition is cleared. (For example, an interrupt handler
    // or cross-triggered event handler clears the overflow status flag by writing to PMOVSCLR_EL0.)

    return pmuirq;
```

Library pseudocode for aarch32/debug/pmu/AArch32.CountEvents

```
// AArch32.CountEvents()
// =====================
// Return TRUE if counter "n" should count its event. For the cycle counter, n == 31.

boolean AArch32.CountEvents(integer n)
    assert n == 31 || n < UInt(PMCR.N);

    if !ELUsingAArch32(EL1) then return AArch64.CountEvents(n);
    // Event counting is disabled in Debug state
    debug = Halted();

    // In Non-secure state, some counters are reserved for EL2
    if HaveEL(EL2) then
        hpmn = if !ELUsingAArch32(EL2) then MDCR_EL2.HPMN else HDCR.HPMN;
        hpme = if !ELUsingAArch32(EL2) then MDCR_EL2.HPME else HDCR.HPME;
        if      E = if n < UInt(hpmn) || n == 31 then PMCR.E else hpme;
    else
        E = PMCR.E;
    enabled = E == '1' && PMCNTENSET<n> == '1';

    if !IsSecure() then
        // Event counting in Non-secure state is allowed unless all of:
        // * EL2 and the HPMD Extension are implemented
        // * Executing at EL2
        // * PMNx is not reserved for EL2
        // * HDCR.HPMD == 1
        if HaveHPMDExt() then
            hpmd = if !() && PSTATE.EL ==ELUsingAArch32(EL2) then MDCR_EL2.HPMD else HDCR.HPMD;
        E = if n <&& (n < UInt(hpmn) || n == 31 then PMCR.E else hpme;
    else
        E = PMCR.E;
    enabled = E == '1' && PMCNTENSET<n> == '1';

    // Event counting in Secure state is prohibited unless any one of:
    // * EL3 is not implemented
    // * EL3 is using AArch64 and MDCR_EL3.SPME == 1
    // * EL3 is using AArch32 and SDCR.SPME == 1
    // * Executing at EL0, and SDER.SUNIDEN == 1.
    spme = (if(hpmn) || n == 31) then
            hpmd = if ! ELUsingAArch32(EL2) then MDCR_EL2.HPMD else HDCR.HPMD;
            prohibited = (hpmd == '1');
        else
            prohibited = FALSE;
    else
        // Event counting in Secure state is prohibited unless any one of:
        // * EL3 is not implemented
        // * EL3 is using AArch64 and MDCR_EL3.SPME == 1
        // * EL3 is using AArch32 and SDCR.SPME == 1
        // * Executing at EL0, and SDER.SUNIDEN == 1.
        spme = (if ELUsingAArch32(EL3) then SDCR.SPME else MDCR_EL3.SPME);
    prohibited = HaveEL(EL3) &&) && spme == '0' && (PSTATE.EL != IsSecure() && spme == '0' && (PSTATE.EL

    // Event counting at EL2 is prohibited if all of:
    // * The HPMD Extension is implemented
    // * Executing at EL2
    // * PMNx is not reserved for EL2
    // * HDCR.HPMD == 1
    if !prohibited && HaveEL(EL2) && HaveHPMDExt() && PSTATE.EL == EL2 && (n < UInt(hpmn) || n == 31) the
        prohibited = (hpmd == '1');
|| SDER.SUNIDEN == '0');

    // The IMPLEMENTATION DEFINED authentication interface might override software controls
    if prohibited && !HaveNoSecurePMUDisableOverride() then
        prohibited = !ExternalSecureNoninvasiveDebugEnabled();
    // For the cycle counter, PMCR.DP enables counting when otherwise prohibited
    if prohibited && n == 31 then prohibited = (PMCR.DP == '1');

    // Event counting can be filtered by the {P, U, NSK, NSU, NSH} bits
    filter = if n == 31 then PMCCFILTR else PMEVTYPER[n];
```

```
    P = filter<31>;
    U = filter<30>;
    NSK = if HaveEL(EL3) then filter<29> else '0';
    NSU = if HaveEL(EL3) then filter<28> else '0';
    NSH = if HaveEL(EL2) then filter<27> else '0';

    case PSTATE.EL of
        when EL0 filtered = if IsSecure() then U == '1' else U != NSU;
        when EL1 filtered = if IsSecure() then P == '1' else P != NSK;
        when EL2 filtered = (NSH == '0');
        when EL3 filtered = (P == '1');

    return !debug && enabled && !prohibited && !filtered;
```

Library pseudocode for aarch32/debug/takeexceptiondbg/AArch32.EnterHypModeInDebugState

```
// AArch32.EnterHypModeInDebugState()
// ==================================
// Take an exception in Debug state to Hyp mode.

AArch32.EnterHypModeInDebugState(ExceptionRecord exception)
    SynchronizeContext();
    assert HaveEL(EL2) && !IsSecure() && ELUsingAArch32(EL2);

    AArch32.ReportHypEntry(exception);
    AArch32.WriteMode(M32_Hyp);
    SPSR[] = bits(32) UNKNOWN;
    ELR_hyp = bits(32) UNKNOWN;
    // In Debug state, the PE always execute T32 instructions when in AArch32 state, and
    // PSTATE.{SS,A,I,F} are not observable so behave as UNKNOWN.
    PSTATE.T = '1';                             // PSTATE.J is RES0
    PSTATE.<SS,A,I,F> = bits(4) UNKNOWN;
    DLR = bits(32) UNKNOWN;
    DSPSR = bits(32) UNKNOWN;
    PSTATE.E = HSCTLR.EE;
    PSTATE.IL = '0';
    PSTATE.IT = '00000000';
    if HaveSSBSExt() then PSTATE.SSBS = bit UNKNOWN;
    EDSCR.ERR = '1';
    UpdateEDSCRFields();

    EndOfInstruction();
```

Library pseudocode for aarch32/debug/takeexceptiondbg/AArch32.EnterModeInDebugState

```
// AArch32.EnterModeInDebugState()
// ===============================
// Take an exception in Debug state to a mode other than Monitor and Hyp mode.

AArch32.EnterModeInDebugState(bits(5) target_mode)
    SynchronizeContext();
    assert ELUsingAArch32(EL1) && PSTATE.EL != EL2;

    if PSTATE.M == M32_Monitor then SCR.NS = '0';
    AArch32.WriteMode(target_mode);
    SPSR[] = bits(32) UNKNOWN;
    R[14] = bits(32) UNKNOWN;
    // In Debug state, the PE always execute T32 instructions when in AArch32 state, and
    // PSTATE.{SS,A,I,F} are not observable so behave as UNKNOWN.
    PSTATE.T = '1';                             // PSTATE.J is RES0
    PSTATE.<SS,A,I,F> = bits(4) UNKNOWN;
    DLR = bits(32) UNKNOWN;
    DSPSR = bits(32) UNKNOWN;
    PSTATE.E = SCTLR.EE;
    PSTATE.IL = '0';
    PSTATE.IT = '00000000';
    if HavePANExt() && SCTLR.SPAN == '0' then PSTATE.PAN = '1';
    if HaveSSBSExt() then PSTATE.SSBS = bit UNKNOWN;
    EDSCR.ERR = '1';
    UpdateEDSCRFields();                        // Update EDSCR processor state flags.

    EndOfInstruction();
```

Library pseudocode for aarch32/debug/takeexceptiondbg/AArch32.EnterMonitorModeInDebugState

```
// AArch32.EnterMonitorModeInDebugState()
// ======================================
// Take an exception in Debug state to Monitor mode.

AArch32.EnterMonitorModeInDebugState()
    SynchronizeContext();
    assert HaveEL(EL3) && ELUsingAArch32(EL3);
    from_secure = IsSecure();
    if PSTATE.M == M32_Monitor then SCR.NS = '0';
    AArch32.WriteMode(M32_Monitor);
    SPSR[] = bits(32) UNKNOWN;
    R[14] = bits(32) UNKNOWN;
    // In Debug state, the PE always execute T32 instructions when in AArch32 state, and
    // PSTATE.{SS,A,I,F} are not observable so behave as UNKNOWN.
    PSTATE.T = '1';                             // PSTATE.J is RES0
    PSTATE.<SS,A,I,F> = bits(4) UNKNOWN;
    PSTATE.E = SCTLR.EE;
    PSTATE.IL = '0';
    PSTATE.IT = '00000000';
    if HavePANExt() then
        if !from_secure then
            PSTATE.PAN = '0';
        elsif SCTLR.SPAN == '0' then
            PSTATE.PAN = '1';
    if HaveSSBSExt() then PSTATE.SSBS = bit UNKNOWN;
    DLR = bits(32) UNKNOWN;
    DSPSR = bits(32) UNKNOWN;
    EDSCR.ERR = '1';
    UpdateEDSCRFields();                        // Update EDSCR processor state flags.

    EndOfInstruction();
```

Library pseudocode for aarch32/debug/watchpoint/AArch32.WatchpointByteMatch

```
// AArch32.WatchpointByteMatch()
// =============================

boolean AArch32.WatchpointByteMatch(integer n,  bits(32) vaddress)

    bottom = if DBGWVR[n]<2> == '1' then 2 else 3;            // Word or doubleword
    byte_select_match = (DBGWCR[n].BAS<UInt(vaddress<bottom-1:0>)> != '0');
    mask = UInt(DBGWCR[n].MASK);

    // If DBGWCR[n].MASK is non-zero value and DBGWCR[n].BAS is not set to '11111111', or
    // DBGWCR[n].BAS specifies a non-contiguous set of bytes behavior is CONSTRAINED
    // UNPREDICTABLE.
    if mask > 0 && !IsOnes(DBGWCR[n].BAS) then
        byte_select_match = ConstrainUnpredictableBool(Unpredictable_WPMASKANDBAS);
    else
        LSB = (DBGWCR[n].BAS AND NOT(DBGWCR[n].BAS - 1));  MSB = (DBGWCR[n].BAS + LSB);
        if !IsZero(MSB AND (MSB - 1)) then                    // Not contiguous
            byte_select_match = ConstrainUnpredictableBool(Unpredictable_WPBASCONTIGUOUS);
            bottom = 3;                                       // For the whole doubleword

    // If the address mask is set to a reserved value, the behavior is CONSTRAINED UNPREDICTABLE.
    if mask > 0 && mask <= 2 then
        (c, mask) = ConstrainUnpredictableInteger(3, 31, Unpredictable_RESWPMASK);
        assert c IN {Constraint_DISABLED, Constraint_NONE, Constraint_UNKNOWN};
        case c of
            when Constraint_DISABLED  return FALSE;           // Disabled
            when Constraint_NONE      mask = 0;               // No masking
            // Otherwise the value returned by ConstrainUnpredictableInteger is a not-reserved value

    if mask > bottom then
        WVR_match = (vaddress<31:mask> == DBGWVR[n]<31:mask>);
        // If masked bits of DBGWVR_EL1[n] are not zero, the behavior is CONSTRAINED UNPREDICTABLE.
        if WVR_match && !IsZero(DBGWVR[n]<mask-1:bottom>) then
            WVR_match = ConstrainUnpredictableBool(Unpredictable_WPMASKEDBITS);
    else
        WVR_match = vaddress<31:bottom> == DBGWVR[n]<31:bottom>;

    return WVR_match && byte_select_match;
```

Library pseudocode for aarch32/debug/watchpoint/AArch32.WatchpointMatch

```
// AArch32.WatchpointMatch()
// =========================
// Watchpoint matching in an AArch32 translation regime.

boolean AArch32.WatchpointMatch(integer n, bits(32) vaddress, integer size, boolean ispriv,
                                boolean iswrite)
    assert ELUsingAArch32(S1TranslationRegime());
    assert n <= UInt(DBGDIDR.WRPs);

    // "ispriv" is FALSE for LDRT/STRT instructions executed at EL1 and all
    // load/stores at EL0, TRUE for all other load/stores. "iswrite" is TRUE for stores, FALSE for
    // loads.
    enabled = DBGWCR[n].E == '1';
    linked = DBGWCR[n].WT == '1';
    isbreakpnt = FALSE;

    state_match = AArch32.StateMatch(DBGWCR[n].SSC, DBGWCR[n].HMC, DBGWCR[n].PAC,
                                     linked, DBGWCR[n].LBN, isbreakpnt, ispriv);

    ls_match = (DBGWCR[n].LSC<(if iswrite then 1 else 0)> == '1');

    value_match = FALSE;
    for byte = 0 to size - 1
        value_match = value_match || AArch32.WatchpointByteMatch(n, vaddress + byte);

    return value_match && state_match && ls_match && enabled;
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.Abort

```
// AArch32.Abort()
// ===============
// Abort and Debug exception handling in an AArch32 translation regime.

AArch32.Abort(bits(32) vaddress, FaultRecord fault)

    // Check if routed to AArch64 state
    route_to_aarch64 = PSTATE.EL == EL0 && !ELUsingAArch32(EL1);

    if !route_to_aarch64 && EL2Enabled() && !ELUsingAArch32(EL2) then
        route_to_aarch64 = (HCR_EL2.TGE == '1' || IsSecondStage(fault) ||
                            (HaveRASExt() && HCR2.TEA == '1' && IsExternalAbort(fault)) ||
                            (IsDebugException(fault) && MDCR_EL2.TDE == '1'));

    if !route_to_aarch64 && HaveEL(EL3) && !ELUsingAArch32(EL3) then
        route_to_aarch64 = SCR_EL3.EA == '1' && IsExternalAbort(fault);

    if route_to_aarch64 then
        AArch64.Abort(ZeroExtend(vaddress), fault);
    elsif fault.acctype == AccType_IFETCH then
        AArch32.TakePrefetchAbortException(vaddress, fault);
    else
        AArch32.TakeDataAbortException(vaddress, fault);
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.AbortSyndrome

```
// AArch32.AbortSyndrome()
// =======================
// Creates an exception syndrome record for Abort  exceptions taken to Hyp mode
// from an AArch32 translation regime.

ExceptionRecord AArch32.AbortSyndrome(Exception exceptype, FaultRecord fault, bits(32) vaddress)
    exception = ExceptionSyndrome(exceptype);

    d_side = exceptype == Exception_DataAbort;

    exception.syndrome = AArch32.FaultSyndrome(d_side, fault);
    exception.vaddress = ZeroExtend(vaddress);
    if IPAValid(fault) then
        exception.ipavalid = TRUE;
        exception.NS = fault.ipaddress.NS;
        exception.ipaddress = ZeroExtend(fault.ipaddress.address);
    else
        exception.ipavalid = FALSE;

    return exception;
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.CheckPCAlignment

```
// AArch32.CheckPCAlignment()
// ==========================

AArch32.CheckPCAlignment()

    bits(32) pc = ThisInstrAddr();
    if (CurrentInstrSet() == InstrSet_A32 && pc<1> == '1') || pc<0> == '1' then
        if AArch32.GeneralExceptionsToAArch64() then AArch64.PCAlignmentFault();

        // Generate an Alignment fault Prefetch Abort exception
        vaddress = pc;
        acctype = AccType_IFETCH;
        iswrite = FALSE;
        secondstage = FALSE;
        AArch32.Abort(vaddress, AArch32.AlignmentFault(acctype, iswrite, secondstage));
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.ReportDataAbort

```
// AArch32.ReportDataAbort()
// =========================
// Report syndrome information for aborts taken to modes other than Hyp mode.

AArch32.ReportDataAbort(boolean route_to_monitor, FaultRecord fault, bits(32) vaddress)

    // The encoding used in the IFSR or DFSR can be Long-descriptor format or Short-descriptor
    // format.  Normally, the current translation table format determines the format. For an abort
    // from Non-secure state to Monitor mode, the IFSR or DFSR uses the Long-descriptor format if
    // any of the following applies:
    // * The Secure TTBCR.EAE is set to 1.
    // * The abort is synchronous and either:
    //   - It is taken from Hyp mode.
    //   - It is taken from EL1 or EL0, and the Non-secure TTBCR.EAE is set to 1.
    long_format = FALSE;
    if route_to_monitor && !IsSecure() then
        long_format = TTBCR_S.EAE == '1';
        if !IsSErrorInterrupt(fault) && !long_format then
            long_format = PSTATE.EL == EL2 || TTBCR.EAE == '1';
    else
        long_format = TTBCR.EAE == '1';
    d_side = TRUE;
    if long_format then
        syndrome = AArch32.FaultStatusLD(d_side, fault);
    else
        syndrome = AArch32.FaultStatusSD(d_side, fault);

    if fault.acctype == AccType_IC then
        if (!long_format &&
            boolean IMPLEMENTATION_DEFINED "Report I-cache maintenance fault in IFSR") then
            i_syndrome = syndrome;
            syndrome<10,3:0> = EncodeSDFSC(Fault_ICacheMaint, 1);
        else
            i_syndrome = bits(32) UNKNOWN;
        if route_to_monitor then
            IFSR_S = i_syndrome;
        else
            IFSR = i_syndrome;

    if route_to_monitor then
        DFSR_S = syndrome;
        DFAR_S = vaddress;
    else
        DFSR = syndrome;
        DFAR = vaddress;

    return;
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.ReportPrefetchAbort

```
// AArch32.ReportPrefetchAbort()
// =============================
// Report syndrome information for aborts taken to modes other than Hyp mode.

AArch32.ReportPrefetchAbort(boolean route_to_monitor, FaultRecord fault, bits(32) vaddress)
    // The encoding used in the IFSR can be Long-descriptor format or Short-descriptor format.
    // Normally, the current translation table format determines the format. For an abort from
    // Non-secure state to Monitor mode, the IFSR uses the Long-descriptor format if any of the
    // following applies:
    // * The Secure TTBCR.EAE is set to 1.
    // * It is taken from Hyp mode.
    // * It is taken from EL1 or EL0, and the Non-secure TTBCR.EAE is set to 1.
    long_format = FALSE;
    if route_to_monitor && !IsSecure() then
        long_format = TTBCR_S.EAE == '1' || PSTATE.EL == EL2 || TTBCR.EAE == '1';
    else
        long_format = TTBCR.EAE == '1';

    d_side = FALSE;
    if long_format then
        fsr = AArch32.FaultStatusLD(d_side, fault);
    else
        fsr = AArch32.FaultStatusSD(d_side, fault);

    if route_to_monitor then
        IFSR_S = fsr;
        IFAR_S = vaddress;
    else
        IFSR = fsr;
        IFAR = vaddress;

    return;
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.TakeDataAbortException

```
// AArch32.TakeDataAbortException()
// ================================

AArch32.TakeDataAbortException(bits(32) vaddress, FaultRecord fault)
    route_to_monitor = HaveEL(EL3) && SCR.EA == '1' && IsExternalAbort(fault);
    route_to_hyp = (HaveEL(EL2) && !IsSecure() && PSTATE.EL IN {EL0, EL1} &&
                    (HCR.TGE == '1' || IsSecondStage(fault) ||
                    (HaveRASExt() && HCR2.TEA == '1' && IsExternalAbort(fault)) ||
                    (IsDebugException(fault) && HDCR.TDE == '1')));
    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x10;
    lr_offset = 8;

    if IsDebugException(fault) then DBGDSCRext.MOE = fault.debugmoe;
    if route_to_monitor then
        AArch32.ReportDataAbort(route_to_monitor, fault, vaddress);
        AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_hyp then
        exception = AArch32.AbortSyndrome(Exception_DataAbort, fault, vaddress);
        if PSTATE.EL == EL2 then
            AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
        else
            AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
    else
        AArch32.ReportDataAbort(route_to_monitor, fault, vaddress);
        AArch32.EnterMode(M32_Abort, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/aborts/AArch32.TakePrefetchAbortException

```
// AArch32.TakePrefetchAbortException()
// ====================================

AArch32.TakePrefetchAbortException(bits(32) vaddress, FaultRecord fault)
    route_to_monitor = HaveEL(EL3) && SCR.EA == '1' && IsExternalAbort(fault);
    route_to_hyp = (HaveEL(EL2) && !IsSecure() && PSTATE.EL IN {EL0, EL1} &&
                    (HCR.TGE == '1' || IsSecondStage(fault) ||
                    (HaveRASExt() && HCR2.TEA == '1' && IsExternalAbort(fault)) ||
                    (IsDebugException(fault) && HDCR.TDE == '1')));

    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0C;
    lr_offset = 4;

    if IsDebugException(fault) then DBGDSCRext.MOE = fault.debugmoe;
    if route_to_monitor then
        AArch32.ReportPrefetchAbort(route_to_monitor, fault, vaddress);
        AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_hyp then
        if fault.statuscode == Fault_Alignment then             // PC Alignment fault
            exception = ExceptionSyndrome(Exception_PCAlignment);
            exception.vaddress = ThisInstrAddr();
        else
            exception = AArch32.AbortSyndrome(Exception_InstructionAbort, fault, vaddress);
        if PSTATE.EL == EL2 then
            AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
        else
            AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
    else
        AArch32.ReportPrefetchAbort(route_to_monitor, fault, vaddress);
        AArch32.EnterMode(M32_Abort, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/aborts/BranchTargetException

```
// BranchTargetException
// =====================
// Raise branch target exception.

AArch64.BranchTargetException(bits(52) vaddress)

    route_to_el2 = PSTATE.EL == EL0 && EL2Enabled() && HCR_EL2.TGE == '1';
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_BranchTarget);
    exception.syndrome<1:0>   = PSTATE.BTYPE;
    exception.syndrome<24:2>  = Zeros();          // RES0

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch32/exceptions/asynch/AArch32.TakePhysicalFIQException

```
// AArch32.TakePhysicalFIQException()
// ==================================

AArch32.TakePhysicalFIQException()

    // Check if routed to AArch64 state
    route_to_aarch64 = PSTATE.EL == EL0 && !ELUsingAArch32(EL1);
    if !route_to_aarch64 && EL2Enabled() && !ELUsingAArch32(EL2) then
        route_to_aarch64 = HCR_EL2.TGE == '1' || (HCR_EL2.FMO == '1' && !IsInHost());

    if !route_to_aarch64 && HaveEL(EL3) && !ELUsingAArch32(EL3) then
        route_to_aarch64 = SCR_EL3.FIQ == '1';

    if route_to_aarch64 then AArch64.TakePhysicalFIQException();
    route_to_monitor = HaveEL(EL3) && SCR.FIQ == '1';
    route_to_hyp = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR.TGE == '1' || HCR.FMO == '1'));
    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x1C;
    lr_offset = 4;
    if route_to_monitor then
        AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_hyp then
        exception = ExceptionSyndrome(Exception_FIQ);
        AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
    else
        AArch32.EnterMode(M32_FIQ, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/asynch/AArch32.TakePhysicalIRQException

```
// AArch32.TakePhysicalIRQException()
// ==================================
// Take an enabled physical IRQ exception.

AArch32.TakePhysicalIRQException()

    // Check if routed to AArch64 state
    route_to_aarch64 = PSTATE.EL == EL0 && !ELUsingAArch32(EL1);
    if !route_to_aarch64 && EL2Enabled() && !ELUsingAArch32(EL2) then
        route_to_aarch64 = HCR_EL2.TGE == '1' || (HCR_EL2.IMO == '1' && !IsInHost());
    if !route_to_aarch64 && HaveEL(EL3) && !ELUsingAArch32(EL3) then
        route_to_aarch64 = SCR_EL3.IRQ == '1';

    if route_to_aarch64 then AArch64.TakePhysicalIRQException();

    route_to_monitor = HaveEL(EL3) && SCR.IRQ == '1';
    route_to_hyp = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR.TGE == '1' || HCR.IMO == '1'));
    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x18;
    lr_offset = 4;
    if route_to_monitor then
        AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_hyp then
        exception = ExceptionSyndrome(Exception_IRQ);
        AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
    else
        AArch32.EnterMode(M32_IRQ, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/asynch/AArch32.TakePhysicalSErrorException

```
// AArch32.TakePhysicalSErrorException()
// =====================================

AArch32.TakePhysicalSErrorException(boolean parity, bit extflag, bits(2) errortype,
                                    boolean impdef_syndrome, bits(24) full_syndrome)

    ClearPendingPhysicalSError();
    // Check if routed to AArch64 state
    route_to_aarch64 = PSTATE.EL == EL0 && !ELUsingAArch32(EL1);

    if !route_to_aarch64 && EL2Enabled() && !ELUsingAArch32(EL2) then
        route_to_aarch64 = (HCR_EL2.TGE == '1' || (!IsInHost() && HCR_EL2.AMO == '1'));
    if !route_to_aarch64 && HaveEL(EL3) && !ELUsingAArch32(EL3) then
        route_to_aarch64 = SCR_EL3.EA == '1';

    if route_to_aarch64 then
        AArch64.TakePhysicalSErrorException(impdef_syndrome, full_syndrome);

    route_to_monitor = HaveEL(EL3) && SCR.EA == '1';
    route_to_hyp = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR.TGE == '1' || HCR.AMO == '1'));
    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x10;
    lr_offset = 8;

    fault = AArch32.AsynchExternalAbort(parity, errortype, extflag);
    vaddress = bits(32) UNKNOWN;
    if route_to_monitor then
        AArch32.ReportDataAbort(route_to_monitor, fault, vaddress);
        AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_hyp then
        exception = AArch32.AbortSyndrome(Exception_DataAbort, fault, vaddress);
        if PSTATE.EL == EL2 then
            AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
        else
            AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
    else
        AArch32.ReportDataAbort(route_to_monitor, fault, vaddress);
        AArch32.EnterMode(M32_Abort, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/asynch/AArch32.TakeVirtualFIQException

```
// AArch32.TakeVirtualFIQException()
// =================================

AArch32.TakeVirtualFIQException()
    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();
    if ELUsingAArch32(EL2) then  // Virtual IRQ enabled if TGE==0 and FMO==1
        assert HCR.TGE == '0' && HCR.FMO == '1';
    else
        assert HCR_EL2.TGE == '0' && HCR_EL2.FMO == '1';
    // Check if routed to AArch64 state
    if PSTATE.EL == EL0 && !ELUsingAArch32(EL1) then AArch64.TakeVirtualFIQException();

    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x1C;
    lr_offset = 4;

    AArch32.EnterMode(M32_FIQ, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/asynch/AArch32.TakeVirtualIRQException

```
// AArch32.TakeVirtualIRQException()
// =================================

AArch32.TakeVirtualIRQException()
    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();

    if ELUsingAArch32(EL2) then   // Virtual IRQs enabled if TGE==0 and IMO==1
        assert HCR.TGE == '0' && HCR.IMO == '1';
    else
        assert HCR_EL2.TGE == '0' && HCR_EL2.IMO == '1';

    // Check if routed to AArch64 state
    if PSTATE.EL == EL0 && !ELUsingAArch32(EL1) then AArch64.TakeVirtualIRQException();

    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x18;
    lr_offset = 4;

    AArch32.EnterMode(M32_IRQ, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/asynch/AArch32.TakeVirtualSErrorException

```
// AArch32.TakeVirtualSErrorException()
// ====================================

AArch32.TakeVirtualSErrorException(bit extflag, bits(2) errortype, boolean impdef_syndrome, bits(24) full

    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();
    if ELUsingAArch32(EL2) then   // Virtual SError enabled if TGE==0 and AMO==1
        assert HCR.TGE == '0' && HCR.AMO == '1';
    else
        assert HCR_EL2.TGE == '0' && HCR_EL2.AMO == '1';
    // Check if routed to AArch64 state
    if PSTATE.EL == EL0 && !ELUsingAArch32(EL1) then AArch64.TakeVirtualSErrorException(impdef_syndrome,

    route_to_monitor = FALSE;

    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x10;
    lr_offset = 8;

    vaddress = bits(32) UNKNOWN;
    parity = FALSE;
    if HaveRASExt() then
        if ELUsingAArch32(EL2) then
            fault = AArch32.AsynchExternalAbort(FALSE, VDFSR.AET, VDFSR.ExT);
        else
            fault = AArch32.AsynchExternalAbort(FALSE, VSESR_EL2.AET, VSESR_EL2.ExT);
    else
        fault = AArch32.AsynchExternalAbort(parity, errortype, extflag);

    ClearPendingVirtualSError();
    AArch32.ReportDataAbort(route_to_monitor, fault, vaddress);
    AArch32.EnterMode(M32_Abort, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/debug/AArch32.SoftwareBreakpoint

```
// AArch32.SoftwareBreakpoint()
// ============================

AArch32.SoftwareBreakpoint(bits(16) immediate)

    if (EL2Enabled() && !ELUsingAArch32(EL2) &&
        (HCR_EL2.TGE == '1' || MDCR_EL2.TDE == '1')) || !ELUsingAArch32(EL1) then
        AArch64.SoftwareBreakpoint(immediate);
    vaddress = bits(32) UNKNOWN;
    acctype = AccType_IFETCH;           // Take as a Prefetch Abort
    iswrite = FALSE;
    entry = DebugException_BKPT;

    fault = AArch32.DebugFault(acctype, iswrite, entry);
    AArch32.Abort(vaddress, fault);
```

Library pseudocode for aarch32/exceptions/debug/DebugException

```
constant bits(4) DebugException_Breakpoint  = '0001';
constant bits(4) DebugException_BKPT        = '0011';
constant bits(4) DebugException_VectorCatch = '0101';
constant bits(4) DebugException_Watchpoint  = '1010';
```

Library pseudocode for aarch32/exceptions/exceptions/AArch32.CheckAdvSIMDOrFPRegisterTraps

```
// AArch32.CheckAdvSIMDOrFPRegisterTraps()
// =======================================
// Check if an instruction that accesses an Advanced SIMD and
// floating-point System register is trapped by an appropriate HCR.TIDx
// ID group trap control.

AArch32.CheckAdvSIMDOrFPRegisterTraps(bits(4) reg)

    if PSTATE.EL == EL1 && EL2Enabled() then
        tid0 = if ELUsingAArch32(EL2) then HCR.TID0 else HCR_EL2.TID0;
        tid3 = if ELUsingAArch32(EL2) then HCR.TID3 else HCR_EL2.TID3;

        if (tid0 == '1' && reg == '0000')                           // FPSID
          || (tid3 == '1' && reg IN {'0101', '0110', '0111'}) then  // MVFRx
            if ELUsingAArch32(EL2) then
                AArch32.SystemAccessTrap(M32_Hyp, 0x8);             // Exception_AdvSIMDFPAccessTrap
            else
                AArch64.AArch32SystemAccessTrap(EL2, 0x8);          // Exception_AdvSIMDFPAccessTrap
```

Library pseudocode for aarch32/exceptions/exceptions/AArch32.ExceptionClass

```
// AArch32.ExceptionClass()
// ========================
// Returns the Exception Class and Instruction Length fields to be reported in HSR

(integer,bit) AArch32.ExceptionClass(Exception exceptype)

    il = if ThisInstrLength() == 32 then '1' else '0';

    case exceptype of
        when Exception_Uncategorized        ec = 0x00; il = '1';
        when Exception_WFxTrap              ec = 0x01;
        when Exception_CP15RTTrap           ec = 0x03;
        when Exception_CP15RRTTrap          ec = 0x04;
        when Exception_CP14RTTrap           ec = 0x05;
        when Exception_CP14DTTrap           ec = 0x06;
        when Exception_AdvSIMDFPAccessTrap  ec = 0x07;
        when Exception_FPIDTrap             ec = 0x08;
        when Exception_PACTrap              ec = 0x09;
        when Exception_TSTARTAccessTrap     ec = 0x1B;
        when Exception_CP14RRTTrap          ec = 0x0C;
        when Exception_BranchTarget         ec = 0x0D;
        when Exception_IllegalState         ec = 0x0E; il = '1';
        when Exception_SupervisorCall       ec = 0x11;
        when Exception_HypervisorCall       ec = 0x12;
        when Exception_MonitorCall          ec = 0x13;
        when Exception_ERetTrap             ec = 0x1A;
        when Exception_InstructionAbort     ec = 0x20; il = '1';
        when Exception_PCAlignment          ec = 0x22; il = '1';
        when Exception_DataAbort            ec = 0x24;
        when Exception_NV2DataAbort         ec = 0x25;
        when Exception_FPTrappedException   ec = 0x28;
        otherwise                           Unreachable();

    if ec IN {0x20,0x24} && PSTATE.EL == EL2 then
        ec = ec + 1;

    return (ec,il);
```

Library pseudocode for aarch32/exceptions/exceptions/AArch32.GeneralExceptionsToAArch64

```
// AArch32.GeneralExceptionsToAArch64()
// ====================================
// Returns TRUE if exceptions normally routed to EL1 are being handled at an Exception
// level using AArch64, because either EL1 is using AArch64 or TGE is in force and EL2
// is using AArch64.

boolean AArch32.GeneralExceptionsToAArch64()
    return ((PSTATE.EL == EL0 && !ELUsingAArch32(EL1)) ||
            (EL2Enabled() && !ELUsingAArch32(EL2) && HCR_EL2.TGE == '1'));
```

Library pseudocode for aarch32/exceptions/exceptions/AArch32.ReportHypEntry

```
// AArch32.ReportHypEntry()
// ========================
// Report syndrome information to Hyp mode registers.

AArch32.ReportHypEntry(ExceptionRecord exception)

    Exception exceptype = exception.exceptype;

    (ec,il) = AArch32.ExceptionClass(exceptype);
    iss = exception.syndrome;

    // IL is not valid for Data Abort exceptions without valid instruction syndrome information
    if ec IN {0x24,0x25} && iss<24> == '0' then
        il = '1';

    HSR = ec<5:0>:il:iss;

    if exceptype IN {Exception_InstructionAbort, Exception_PCAlignment} then
        HIFAR = exception.vaddress<31:0>;
        HDFAR = bits(32) UNKNOWN;
    elsif exceptype == Exception_DataAbort then
        HIFAR = bits(32) UNKNOWN;
        HDFAR = exception.vaddress<31:0>;

    if exception.ipavalid then
        HPFAR<31:4> = exception.ipaddress<39:12>;
    else
        HPFAR<31:4> = bits(28) UNKNOWN;

    return;
```

Library pseudocode for aarch32/exceptions/exceptions/AArch32.ResetControlRegisters

```
// Resets System registers and memory-mapped control registers that have architecturally-defined
// reset values to those values.
AArch32.ResetControlRegisters(boolean cold_reset);
```

Library pseudocode for aarch32/exceptions/exceptions/AArch32.TakeReset

```
// AArch32.TakeReset()
// ===================
// Reset into AArch32 state

AArch32.TakeReset(boolean cold_reset)
    assert HighestELUsingAArch32();

    // Enter the highest implemented Exception level in AArch32 state
    if HaveEL(EL3) then
        AArch32.WriteMode(M32_Svc);
        SCR.NS = '0';                     // Secure state
    elsif HaveEL(EL2) then
        AArch32.WriteMode(M32_Hyp);
    else
        AArch32.WriteMode(M32_Svc);

    // Reset the CP14 and CP15 registers and other system components
    AArch32.ResetControlRegisters(cold_reset);
    FPEXC.EN = '0';

    // Reset all other PSTATE fields, including instruction set and endianness according to the
    // SCTLR values produced by the above call to ResetControlRegisters()
    PSTATE.<A,I,F> = '111';       // All asynchronous exceptions masked
    PSTATE.IT = '00000000';       // IT block state reset
    PSTATE.T = SCTLR.TE;          // Instruction set: TE=0: A32, TE=1: T32. PSTATE.J is RES0.
    PSTATE.E = SCTLR.EE;          // Endianness: EE=0: little-endian, EE=1: big-endian
    PSTATE.IL = '0';              // Clear Illegal Execution state bit

    // All registers, bits and fields not reset by the above pseudocode or by the BranchTo() call
    // below are UNKNOWN bitstrings after reset. In particular, the return information registers
    // R14 or ELR_hyp and SPSR have UNKNOWN values, so that it
    // is impossible to return from a reset in an architecturally defined way.
    AArch32.ResetGeneralRegisters();
    AArch32.ResetSIMDFPRegisters();
    AArch32.ResetSpecialRegisters();
    ResetExternalDebugRegisters(cold_reset);

    bits(32) rv;                      // IMPLEMENTATION DEFINED reset vector

    if HaveEL(EL3) then
        if MVBAR<0> == '1' then           // Reset vector in MVBAR
            rv = MVBAR<31:1>:'0';
        else
            rv = bits(32) IMPLEMENTATION_DEFINED "reset vector address";
    else
        rv = RVBAR<31:1>:'0';

    // The reset vector must be correctly aligned
    assert rv<0> == '0' && (PSTATE.T == '1' || rv<1> == '0');

    BranchTo(rv, BranchType_RESET);
```

Library pseudocode for aarch32/exceptions/exceptions/ExcVectorBase

```
// ExcVectorBase()
// ===============

bits(32) ExcVectorBase()
    if SCTLR.V == '1' then  // Hivecs selected, base = 0xFFFF0000
        return Ones(16):Zeros(16);
    else
        return VBAR<31:5>:Zeros(5);
```

Library pseudocode for aarch32/exceptions/ieeefp/AArch32.FPTrappedException

```
// AArch32.FPTrappedException()
// ============================

AArch32.FPTrappedException(bits(8) accumulated_exceptions)
    if AArch32.GeneralExceptionsToAArch64() then
        is_ase = FALSE;
        element = 0;
        AArch64.FPTrappedException(is_ase, element, accumulated_exceptions);
    FPEXC.DEX    = '1';
    FPEXC.TFV    = '1';
    FPEXC<7,4:0> = accumulated_exceptions<7,4:0>;                 // IDF,IXF,UFF,OFF,DZF,IOF
    FPEXC<10:8>  = '111';                                         // VECITR is RES1

    AArch32.TakeUndefInstrException();
```

Library pseudocode for aarch32/exceptions/syscalls/AArch32.CallHypervisor

```
// AArch32.CallHypervisor()
// ========================
// Performs a HVC call

AArch32.CallHypervisor(bits(16) immediate)
    assert HaveEL(EL2);

    if !ELUsingAArch32(EL2) then
        AArch64.CallHypervisor(immediate);
    else
        AArch32.TakeHVCException(immediate);
```

Library pseudocode for aarch32/exceptions/syscalls/AArch32.CallSupervisor

```
// AArch32.CallSupervisor()
// ========================
// Calls the Supervisor

AArch32.CallSupervisor(bits(16) immediate)

    if AArch32.CurrentCond() != '1110' then
        immediate = bits(16) UNKNOWN;
    if AArch32.GeneralExceptionsToAArch64() then
        AArch64.CallSupervisor(immediate);
    else
        AArch32.TakeSVCException(immediate);
```

Library pseudocode for aarch32/exceptions/syscalls/AArch32.TakeHVCException

```
// AArch32.TakeHVCException()
// ==========================

AArch32.TakeHVCException(bits(16) immediate)
    assert HaveEL(EL2) && ELUsingAArch32(EL2);

    AArch32.ITAdvance();
    SSAdvance();
    bits(32) preferred_exception_return = NextInstrAddr();
    vect_offset = 0x08;

    exception = ExceptionSyndrome(Exception_HypervisorCall);
    exception.syndrome<15:0> = immediate;

    if PSTATE.EL == EL2 then
        AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
    else
        AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
```

Library pseudocode for aarch32/exceptions/syscalls/AArch32.TakeSMCException

```
// AArch32.TakeSMCException()
// ==========================

AArch32.TakeSMCException()
    assert HaveEL(EL3) && ELUsingAArch32(EL3);
    AArch32.ITAdvance();
    SSAdvance();
    bits(32) preferred_exception_return = NextInstrAddr();
    vect_offset = 0x08;
    lr_offset = 0;

    AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/syscalls/AArch32.TakeSVCException

```
// AArch32.TakeSVCException()
// ==========================

AArch32.TakeSVCException(bits(16) immediate)

    AArch32.ITAdvance();
    SSAdvance();
    route_to_hyp = PSTATE.EL == EL0 && EL2Enabled() && HCR.TGE == '1';

    bits(32) preferred_exception_return = NextInstrAddr();
    vect_offset = 0x08;
    lr_offset = 0;

    if PSTATE.EL == EL2 || route_to_hyp then
        exception = ExceptionSyndrome(Exception_SupervisorCall);
        exception.syndrome<15:0> = immediate;
        if PSTATE.EL == EL2 then
            AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
        else
            AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
    else
        AArch32.EnterMode(M32_Svc, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/takeexception/AArch32.EnterHypMode

```
// AArch32.EnterHypMode()
// ======================
// Take an exception to Hyp mode.

AArch32.EnterHypMode(ExceptionRecord exception, bits(32) preferred_exception_return,
                     integer vect_offset)
    SynchronizeContext();
    assert HaveEL(EL2) && !IsSecure() && ELUsingAArch32(EL2);

    spsr = GetPSRFromPSTATE();
    if !(exception.exceptype IN {Exception_IRQ, Exception_FIQ}) then
        AArch32.ReportHypEntry(exception);
    AArch32.WriteMode(M32_Hyp);
    SPSR[] = spsr;
    ELR_hyp = preferred_exception_return;
    PSTATE.T = HSCTLR.TE;                       // PSTATE.J is RES0
    PSTATE.SS = '0';
    if !HaveEL(EL3) || SCR_GEN[].EA == '0' then PSTATE.A = '1';
    if !HaveEL(EL3) || SCR_GEN[].IRQ == '0' then PSTATE.I = '1';
    if !HaveEL(EL3) || SCR_GEN[].FIQ == '0' then PSTATE.F = '1';
    PSTATE.E = HSCTLR.EE;
    PSTATE.IL = '0';
    PSTATE.IT = '00000000';
    if HaveSSBSExt() then PSTATE.SSBS = HSCTLR.DSSBS;
    BranchTo(HVBAR<31:5>:vect_offset<4:0>, BranchType_EXCEPTION);

    EndOfInstruction();
```

Library pseudocode for aarch32/exceptions/takeexception/AArch32.EnterMode

```
// AArch32.EnterMode()
// ===================
// Take an exception to a mode other than Monitor and Hyp mode.

AArch32.EnterMode(bits(5) target_mode, bits(32) preferred_exception_return, integer lr_offset,
                  integer vect_offset)
    SynchronizeContext();
    assert ELUsingAArch32(EL1) && PSTATE.EL != EL2;

    spsr = GetPSRFromPSTATE();
    if PSTATE.M == M32_Monitor then SCR.NS = '0';
    AArch32.WriteMode(target_mode);
    SPSR[] = spsr;
    R[14] = preferred_exception_return + lr_offset;
    PSTATE.T = SCTLR.TE;                        // PSTATE.J is RES0
    PSTATE.SS = '0';
    if target_mode == M32_FIQ then
        PSTATE.<A,I,F> = '111';
    elsif target_mode IN {M32_Abort, M32_IRQ} then
        PSTATE.<A,I> = '11';
    else
        PSTATE.I = '1';
    PSTATE.E = SCTLR.EE;
    PSTATE.IL = '0';
    PSTATE.IT = '00000000';
    if HavePANExt() && SCTLR.SPAN == '0' then PSTATE.PAN = '1';
    if HaveSSBSExt() then PSTATE.SSBS = SCTLR.DSSBS;
    BranchTo(ExcVectorBase()<31:5>:vect_offset<4:0>, BranchType_EXCEPTION);

    EndOfInstruction();
```

Library pseudocode for aarch32/exceptions/takeexception/AArch32.EnterMonitorMode

```
// AArch32.EnterMonitorMode()
// ==========================
// Take an exception to Monitor mode.

AArch32.EnterMonitorMode(bits(32) preferred_exception_return, integer lr_offset,
                         integer vect_offset)
    SynchronizeContext();
    assert HaveEL(EL3) && ELUsingAArch32(EL3);
    from_secure = IsSecure();
    spsr = GetPSRFromPSTATE();
    if PSTATE.M == M32_Monitor then SCR.NS = '0';
    AArch32.WriteMode(M32_Monitor);
    SPSR[] = spsr;
    R[14] = preferred_exception_return + lr_offset;
    PSTATE.T = SCTLR.TE;                        // PSTATE.J is RES0
    PSTATE.SS = '0';
    PSTATE.<A,I,F> = '111';
    PSTATE.E = SCTLR.EE;
    PSTATE.IL = '0';
    PSTATE.IT = '00000000';
    if HavePANExt() then
        if !from_secure then
            PSTATE.PAN = '0';
        elsif SCTLR.SPAN == '0' then
            PSTATE.PAN = '1';
    if HaveSSBSExt() then PSTATE.SSBS = SCTLR.DSSBS;
    BranchTo(MVBAR<31:5>:vect_offset<4:0>, BranchType_EXCEPTION);

    EndOfInstruction();
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckAdvSIMDOrFPEnabled

```
// AArch32.CheckAdvSIMDOrFPEnabled()
// =================================
// Check against CPACR, FPEXC, HCPTR, NSACR, and CPTR_EL3.

AArch32.CheckAdvSIMDOrFPEnabled(boolean fpexc_check, boolean advsimd)
    if PSTATE.EL == EL0 && (!HaveEL(EL2) || (!ELUsingAArch32(EL2) && HCR_EL2.TGE == '0')) && !ELUsingAArc
        // The PE behaves as if FPEXC.EN is 1
        AArch64.CheckFPAdvSIMDEnabled();
    elsif PSTATE.EL == EL0 && HaveEL(EL2) && !ELUsingAArch32(EL2) && HCR_EL2.TGE == '1' && !ELUsingAArch3
        if fpexc_check && HCR_EL2.RW == '0' then
            fpexc_en = bits(1) IMPLEMENTATION_DEFINED "FPEXC.EN value when TGE==1 and RW==0";
            if fpexc_en == '0' then UNDEFINED;
        AArch64.CheckFPAdvSIMDEnabled();
    else
        cpacr_asedis = CPACR.ASEDIS;
        cpacr_cp10 = CPACR.cp10;

        if HaveEL(EL3) && ELUsingAArch32(EL3) && !IsSecure() then
            // Check if access disabled in NSACR
            if NSACR.NSASEDIS == '1' then cpacr_asedis = '1';
            if NSACR.cp10 == '0' then cpacr_cp10 = '00';

        if PSTATE.EL != EL2 then
            // Check if Advanced SIMD disabled in CPACR
            if advsimd && cpacr_asedis == '1' then UNDEFINED;

            if cpacr_cp10 == '10' then
                (c, cpacr_cp10) = ConstrainUnpredictableBits(Unpredictable_RESCPACR);

            // Check if access disabled in CPACR
            case cpacr_cp10 of
                when '00'  disabled = TRUE;
                when '01'  disabled = PSTATE.EL == EL0;
                when '11'  disabled = FALSE;
            if disabled then UNDEFINED;

        // If required, check FPEXC enabled bit.
        if fpexc_check && FPEXC.EN == '0' then UNDEFINED;

        AArch32.CheckFPAdvSIMDTrap(advsimd);    // Also check against HCPTR and CPTR_EL3
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckFPAdvSIMDTrap

```
// AArch32.CheckFPAdvSIMDTrap()
// ============================
// Check against CPTR_EL2 and CPTR_EL3.

AArch32.CheckFPAdvSIMDTrap(boolean advsimd)
    if EL2Enabled() && !ELUsingAArch32(EL2) then
        AArch64.CheckFPAdvSIMDTrap();
    else
        if HaveEL(EL2) && !IsSecure() then
            hcptr_tase = HCPTR.TASE;
            hcptr_cp10 = HCPTR.TCP10;

            if HaveEL(EL3) && ELUsingAArch32(EL3) && !IsSecure() then
                // Check if access disabled in NSACR
                if NSACR.NSASEDIS == '1' then hcptr_tase = '1';
                if NSACR.cp10 == '0' then hcptr_cp10 = '1';

            // Check if access disabled in HCPTR
            if (advsimd && hcptr_tase == '1') || hcptr_cp10 == '1' then
                exception = ExceptionSyndrome(Exception_AdvSIMDFPAccessTrap);
                exception.syndrome<24:20> = ConditionSyndrome();

                if advsimd then
                    exception.syndrome<5> = '1';
                else
                    exception.syndrome<5> = '0';
                    exception.syndrome<3:0> = '1010';         // coproc field, always 0xA

                if PSTATE.EL == EL2 then
                    AArch32.TakeUndefInstrException(exception);
                else
                    AArch32.TakeHypTrapException(exception);

        if HaveEL(EL3) && !ELUsingAArch32(EL3) then
            // Check if access disabled in CPTR_EL3
            if CPTR_EL3.TFP == '1' then AArch64.AdvSIMDFPAccessTrap(EL3);
    return;
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckForSMCUndefOrTrap

```
// AArch32.CheckForSMCUndefOrTrap()
// ================================
// Check for UNDEFINED or trap on SMC instruction

AArch32.CheckForSMCUndefOrTrap()
    if !HaveEL(EL3) || PSTATE.EL == EL0 then
        UNDEFINED;

    if EL2Enabled() && !ELUsingAArch32(EL2) then
        AArch64.CheckForSMCUndefOrTrap(Zeros(16));
    else
        route_to_hyp = HaveEL(EL2) && !IsSecure() && PSTATE.EL == EL1 && HCR.TSC == '1';
        if route_to_hyp then
            exception = ExceptionSyndrome(Exception_MonitorCall);
            AArch32.TakeHypTrapException(exception);
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckForWFxTrap

```
// AArch32.CheckForWFxTrap()
// =========================
// Check for trap on WFE or WFI instruction

AArch32.CheckForWFxTrap(bits(2) target_el, boolean is_wfe)
    assert HaveEL(target_el);

    // Check for routing to AArch64
    if !ELUsingAArch32(target_el) then
        AArch64.CheckForWFxTrap(target_el, is_wfe);
        return;
    case target_el of
        when EL1 trap = (if is_wfe then SCTLR.nTWE else SCTLR.nTWI) == '0';
        when EL2 trap = (if is_wfe then HCR.TWE else HCR.TWI) == '1';
        when EL3 trap = (if is_wfe then SCR.TWE else SCR.TWI) == '1';
    if trap then
        if target_el == EL1 && EL2Enabled() && !ELUsingAArch32(EL2) && HCR_EL2.TGE == '1' then
            AArch64.WFxTrap(target_el, is_wfe);
        if target_el == EL3 then
            AArch32.TakeMonitorTrapException();
        elsif target_el == EL2 then
            exception = ExceptionSyndrome(Exception_WFxTrap);
            exception.syndrome<24:20> = ConditionSyndrome();
            exception.syndrome<0> = if is_wfe then '1' else '0';
            AArch32.TakeHypTrapException(exception);
        else
            AArch32.TakeUndefInstrException();
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckITEnabled

```
// AArch32.CheckITEnabled()
// ========================
// Check whether the T32 IT instruction is disabled.

AArch32.CheckITEnabled(bits(4) mask)
    if PSTATE.EL == EL2 then
        it_disabled = HSCTLR.ITD;
    else
        it_disabled = (if ELUsingAArch32(EL1) then SCTLR.ITD else SCTLR[].ITD);
    if it_disabled == '1' then
        if mask != '1000' then UNDEFINED;

        // Otherwise whether the IT block is allowed depends on hw1 of the next instruction.
        next_instr = AArch32.MemSingle[NextInstrAddr(), 2, AccType_IFETCH, TRUE];

        if next_instr IN {'11xxxxxxxxxxxxxx', '1011xxxxxxxxxxxx', '10100xxxxxxxxxxx',
                          '01001xxxxxxxxxxx', '010001xxx1111xxx', '010001xx1xxxx111'} then
            // It is IMPLEMENTATION DEFINED whether the Undefined Instruction exception is
            // taken on the IT instruction or the next instruction. This is not reflected in
            // the pseudocode, which always takes the exception on the IT instruction. This
            // also does not take into account cases where the next instruction is UNPREDICTABLE.
            UNDEFINED;

    return;
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckIllegalState

```
// AArch32.CheckIllegalState()
// ===========================
// Check PSTATE.IL bit and generate Illegal Execution state exception if set.

AArch32.CheckIllegalState()
    if AArch32.GeneralExceptionsToAArch64() then
        AArch64.CheckIllegalState();
    elsif PSTATE.IL == '1' then
        route_to_hyp = PSTATE.EL == EL0 && EL2Enabled() && HCR.TGE == '1';

        bits(32) preferred_exception_return = ThisInstrAddr();
        vect_offset = 0x04;

        if PSTATE.EL == EL2 || route_to_hyp then
            exception = ExceptionSyndrome(Exception_IllegalState);
            if PSTATE.EL == EL2 then
                AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
            else
                AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
        else
            AArch32.TakeUndefInstrException();
```

Library pseudocode for aarch32/exceptions/traps/AArch32.CheckSETENDEnabled

```
// AArch32.CheckSETENDEnabled()
// ============================
// Check whether the AArch32 SETEND instruction is disabled.

AArch32.CheckSETENDEnabled()
    if PSTATE.EL == EL2 then
        setend_disabled = HSCTLR.SED;
    else
        setend_disabled = (if ELUsingAArch32(EL1) then SCTLR.SED else SCTLR[].SED);
    if setend_disabled == '1' then
        UNDEFINED;

    return;
```

Library pseudocode for aarch32/exceptions/traps/AArch32.SystemAccessTrap

```
// AArch32.SystemAccessTrap()
// ==========================
// Trapped  system register access.

AArch32.SystemAccessTrap(bits(5) mode, integer ec)
    (valid, target_el) = ELFromM32(mode);
    assert valid && HaveEL(target_el) && target_el != EL0 && UInt(target_el) >= UInt(PSTATE.EL);

    if target_el == EL2 then
        exception = AArch32.SystemAccessTrapSyndrome(ThisInstr(), ec);
        AArch32.TakeHypTrapException(exception);
    else
        AArch32.TakeUndefInstrException();
```

Library pseudocode for aarch32/exceptions/traps/AArch32.SystemAccessTrapSyndrome

```
// AArch32.SystemAccessTrapSyndrome()
// ==================================
// Returns the syndrome information for traps on AArch32 MCR, MCRR, MRC, MRRC, and VMRS, VMSR instruction
// other than traps that are due to HCPTR or CPACR.

ExceptionRecord AArch32.SystemAccessTrapSyndrome(bits(32) instr, integer ec)
    ExceptionRecord exception;

    case ec of
        when 0x0    exception = ExceptionSyndrome(Exception_Uncategorized);
        when 0x3    exception = ExceptionSyndrome(Exception_CP15RTTrap);
        when 0x4    exception = ExceptionSyndrome(Exception_CP15RRTTrap);
        when 0x5    exception = ExceptionSyndrome(Exception_CP14RTTrap);
        when 0x6    exception = ExceptionSyndrome(Exception_CP14DTTrap);
        when 0x7    exception = ExceptionSyndrome(Exception_AdvSIMDFPAccessTrap);
        when 0x8    exception = ExceptionSyndrome(Exception_FPIDTrap);
        when 0xC    exception = ExceptionSyndrome(Exception_CP14RRTTrap);
        otherwise   Unreachable();

    bits(20) iss = Zeros();

    if exception.exceptype IN {Exception_FPIDTrap, Exception_CP14RTTrap, Exception_CP15RTTrap} then
        // Trapped MRC/MCR, VMRS on FPSID
        iss<19:17> = instr<7:5>;           // opc2
        iss<16:14> = instr<23:21>;         // opc1
        iss<13:10> = instr<19:16>;         // CRn
        iss<8:5>   = instr<15:12>;         // Rt
    elsif exception.exceptype IN {Exception_CP14RRTTrap, Exception_AdvSIMDFPAccessTrap, Exception_CP15RRT
        // Trapped MRRC/MCRR, VMRS/VMSR
        iss<19:16> = instr<7:4>;          // opc1
        iss<13:10> = instr<19:16>;        // Rt2
        iss<8:5> = instr<15:12>;          // Rt
        iss<4:1>   = instr<3:0>;         // CRm
    elsif exception.exceptype == Exception_CP14DTTrap then
        // Trapped LDC/STC
        iss<19:12> = instr<7:0>;         // imm8
        iss<4>     = instr<23>;          // U
        iss<2:1>   = instr<24,21>;       // P,W
        if instr<19:16> == '1111' then   // Rn==15, LDC(Literal addressing)/STC
            iss<8:5> = bits(4) UNKNOWN;
            iss<3>   = '1';
    elsif exception.exceptype == Exception_Uncategorized then
        // Trapped for unknown reason
        iss<8:5> = instr<19:16>;         // Rn
        iss<3>   = '0';

    iss<0> = instr<20>;                  // Direction

    exception.syndrome<24:20> = ConditionSyndrome();
    exception.syndrome<19:0>  = iss;

    return exception;
```

Library pseudocode for aarch32/exceptions/traps/AArch32.TakeHypTrapException

```
// AArch32.TakeHypTrapException()
// ==============================
// Exceptions routed to Hyp mode as a Hyp Trap exception.

AArch32.TakeHypTrapException(integer ec)
    exception = AArch32.SystemAccessTrapSyndrome(ThisInstr(), ec);
    AArch32.TakeHypTrapException(exception);

// AArch32.TakeHypTrapException()
// ==============================
// Exceptions routed to Hyp mode as a Hyp Trap exception.

AArch32.TakeHypTrapException(ExceptionRecord exception)
    assert HaveEL(EL2) && !IsSecure() && ELUsingAArch32(EL2);

    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x14;

    AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch32/exceptions/traps/AArch32.TakeMonitorTrapException

```
// AArch32.TakeMonitorTrapException()
// ==================================
// Exceptions routed to Monitor mode as a Monitor Trap exception.

AArch32.TakeMonitorTrapException()
    assert HaveEL(EL3) && ELUsingAArch32(EL3);

    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x04;
    lr_offset = if CurrentInstrSet() == InstrSet_A32 then 4 else 2;

    AArch32.EnterMonitorMode(preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/traps/AArch32.TakeUndefInstrException

```
// AArch32.TakeUndefInstrException()
// =================================

AArch32.TakeUndefInstrException()
    exception = ExceptionSyndrome(Exception_Uncategorized);
    AArch32.TakeUndefInstrException(exception);

// AArch32.TakeUndefInstrException()
// =================================

AArch32.TakeUndefInstrException(ExceptionRecord exception)

    route_to_hyp = PSTATE.EL == EL0 && EL2Enabled() && HCR.TGE == '1';
    bits(32) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x04;
    lr_offset = if CurrentInstrSet() == InstrSet_A32 then 4 else 2;

    if PSTATE.EL == EL2 then
        AArch32.EnterHypMode(exception, preferred_exception_return, vect_offset);
    elsif route_to_hyp then
        AArch32.EnterHypMode(exception, preferred_exception_return, 0x14);
    else
        AArch32.EnterMode(M32_Undef, preferred_exception_return, lr_offset, vect_offset);
```

Library pseudocode for aarch32/exceptions/traps/AArch32.UndefinedFault

```
// AArch32.UndefinedFault()
// ========================

AArch32.UndefinedFault()

    if AArch32.GeneralExceptionsToAArch64() then AArch64.UndefinedFault();
    AArch32.TakeUndefInstrException();
```

Library pseudocode for aarch32/functions/aborts/AArch32.CreateFaultRecord

```
// AArch32.CreateFaultRecord()
// ===========================

FaultRecord AArch32.CreateFaultRecord(Fault statuscode, bits(40) ipaddress,   bits(4) domain,
                                      integer level, AccType acctype, boolean write, bit extflag,
                                      bits(4) debugmoe, bits(2) errortype, boolean secondstage, boolean s

    FaultRecord fault;
    fault.statuscode = statuscode;
    if (statuscode != Fault_None && PSTATE.EL != EL2 && TTBCR.EAE == '0' && !secondstage && !s2fs1walk &&
        AArch32.DomainValid(statuscode, level)) then
        fault.domain = domain;
    else
        fault.domain = bits(4) UNKNOWN;
    fault.debugmoe = debugmoe;
    fault.errortype = errortype;
    fault.ipaddress.NS = bit UNKNOWN;
    fault.ipaddress.address = ZeroExtend(ipaddress);
    fault.level = level;
    fault.acctype = acctype;
    fault.write = write;
    fault.extflag = extflag;
    fault.secondstage = secondstage;
    fault.s2fs1walk = s2fs1walk;

    return fault;
```

Library pseudocode for aarch32/functions/aborts/AArch32.DomainValid

```
// AArch32.DomainValid()
// =====================
// Returns TRUE if the Domain is valid for a Short-descriptor translation scheme.

boolean AArch32.DomainValid(Fault statuscode, integer level)
    assert statuscode != Fault_None;

    case statuscode of
        when Fault_Domain
            return TRUE;
        when Fault_Translation, Fault_AccessFlag, Fault_SyncExternalOnWalk, Fault_SyncParityOnWalk
            return level == 2;
        otherwise
            return FALSE;
```

Library pseudocode for aarch32/functions/aborts/AArch32.FaultStatusLD

```
// AArch32.FaultStatusLD()
// =======================
// Creates an exception fault status value for Abort and Watchpoint exceptions taken
// to Abort mode using AArch32 and Long-descriptor format.

bits(32) AArch32.FaultStatusLD(boolean d_side, FaultRecord fault)
    assert fault.statuscode != Fault_None;

    bits(32) fsr = Zeros();
    if HaveRASExt() && IsAsyncAbort(fault) then fsr<15:14> = fault.errortype;
    if d_side then
        if fault.acctype IN {AccType_DC, AccType_IC, AccType_AT} then
            fsr<13> = '1'; fsr<11> = '1';
        else
            fsr<11> = if fault.write then '1' else '0';
    if IsExternalAbort(fault) then fsr<12> = fault.extflag;
    fsr<9> = '1';
    fsr<5:0> = EncodeLDFSC(fault.statuscode, fault.level);

    return fsr;
```

Library pseudocode for aarch32/functions/aborts/AArch32.FaultStatusSD

```
// AArch32.FaultStatusSD()
// =======================
// Creates an exception fault status value for Abort and Watchpoint exceptions taken
// to Abort mode using AArch32 and Short-descriptor format.

bits(32) AArch32.FaultStatusSD(boolean d_side, FaultRecord fault)
    assert fault.statuscode != Fault_None;

    bits(32) fsr = Zeros();
    if HaveRASExt() && IsAsyncAbort(fault) then fsr<15:14> = fault.errortype;
    if d_side then
        if fault.acctype IN {AccType_DC, AccType_IC, AccType_AT} then
            fsr<13> = '1'; fsr<11> = '1';
        else
            fsr<11> = if fault.write then '1' else '0';
    if IsExternalAbort(fault) then fsr<12> = fault.extflag;
    fsr<9> = '0';
    fsr<10,3:0> = EncodeSDFSC(fault.statuscode, fault.level);
    if d_side then
        fsr<7:4> = fault.domain;              // Domain field (data fault only)

    return fsr;
```

Library pseudocode for aarch32/functions/aborts/AArch32.FaultSyndrome

```
// AArch32.FaultSyndrome()
// =======================
// Creates an exception syndrome value for Abort and Watchpoint exceptions taken to
// AArch32 Hyp mode.

bits(25) AArch32.FaultSyndrome(boolean d_side, FaultRecord fault)
    assert fault.statuscode != Fault_None;

    bits(25) iss = Zeros();
    if HaveRASExt() && IsAsyncAbort(fault) then iss<11:10> = fault.errortype; // AET
    if d_side then
        if IsSecondStage(fault) && !fault.s2fs1walk then iss<24:14> = LSInstructionSyndrome();
        if fault.acctype IN {AccType_DC, AccType_DC_UNPRIV, AccType_IC, AccType_AT} then
            iss<8> = '1';  iss<6> = '1';
        else
            iss<6> = if fault.write then '1' else '0';
    if IsExternalAbort(fault) then iss<9> = fault.extflag;
    iss<7> = if fault.s2fs1walk then '1' else '0';
    iss<5:0> = EncodeLDFSC(fault.statuscode, fault.level);

    return iss;
```

Library pseudocode for aarch32/functions/aborts/EncodeSDFSC

```
// EncodeSDFSC()
// =============
// Function that gives the Short-descriptor FSR code for different types of Fault

bits(5) EncodeSDFSC(Fault statuscode, integer level)

    bits(5) result;
    case statuscode of
        when Fault_AccessFlag
            assert level IN {1,2};
            result = if level == 1 then '00011' else '00110';
        when Fault_Alignment
            result = '00001';
        when Fault_Permission
            assert level IN {1,2};
            result = if level == 1 then '01101' else '01111';
        when Fault_Domain
            assert level IN {1,2};
            result = if level == 1 then '01001' else '01011';
        when Fault_Translation
            assert level IN {1,2};
            result = if level == 1 then '00101' else '00111';
        when Fault_SyncExternal
            result = '01000';
        when Fault_SyncExternalOnWalk
            assert level IN {1,2};
            result = if level == 1 then '01100' else '01110';
        when Fault_SyncParity
            result = '11001';
        when Fault_SyncParityOnWalk
            assert level IN {1,2};
            result = if level == 1 then '11100' else '11110';
        when Fault_AsyncParity
            result = '11000';
        when Fault_AsyncExternal
            result = '10110';
        when Fault_Debug
            result = '00010';
        when Fault_TLBConflict
            result = '10000';
        when Fault_Lockdown
            result = '10100';   // IMPLEMENTATION DEFINED
        when Fault_Exclusive
            result = '10101';   // IMPLEMENTATION DEFINED
        when Fault_ICacheMaint
            result = '00100';
        otherwise
            Unreachable();

    return result;
```

Library pseudocode for aarch32/functions/common/A32ExpandImm

```
// A32ExpandImm()
// ==============

bits(32) A32ExpandImm(bits(12) imm12)

    // PSTATE.C argument to following function call does not affect the imm32 result.
    (imm32, -) = A32ExpandImm_C(imm12, PSTATE.C);

    return imm32;
```

Library pseudocode for aarch32/functions/common/A32ExpandImm_C

```
// A32ExpandImm_C()
// ================

(bits(32), bit) A32ExpandImm_C(bits(12) imm12, bit carry_in)

    unrotated_value = ZeroExtend(imm12<7:0>, 32);
    (imm32, carry_out) = Shift_C(unrotated_value, SRType_ROR, 2*UInt(imm12<11:8>), carry_in);

    return (imm32, carry_out);
```

Library pseudocode for aarch32/functions/common/DecodeImmShift

```
// DecodeImmShift()
// ================

(SRType, integer) DecodeImmShift(bits(2) srtype, bits(5) imm5)

    case srtype of
        when '00'
            shift_t = SRType_LSL;  shift_n = UInt(imm5);
        when '01'
            shift_t = SRType_LSR;  shift_n = if imm5 == '00000' then 32 else UInt(imm5);
        when '10'
            shift_t = SRType_ASR;  shift_n = if imm5 == '00000' then 32 else UInt(imm5);
        when '11'
            if imm5 == '00000' then
                shift_t = SRType_RRX;  shift_n = 1;
            else
                shift_t = SRType_ROR;  shift_n = UInt(imm5);

    return (shift_t, shift_n);
```

Library pseudocode for aarch32/functions/common/DecodeRegShift

```
// DecodeRegShift()
// ================

SRType DecodeRegShift(bits(2) srtype)
    case srtype of
        when '00'  shift_t = SRType_LSL;
        when '01'  shift_t = SRType_LSR;
        when '10'  shift_t = SRType_ASR;
        when '11'  shift_t = SRType_ROR;
    return shift_t;
```

Library pseudocode for aarch32/functions/common/RRX

```
// RRX()
// =====

bits(N) RRX(bits(N) x, bit carry_in)
    (result, -) = RRX_C(x, carry_in);
    return result;
```

Library pseudocode for aarch32/functions/common/RRX_C

```
// RRX_C()
// =======

(bits(N), bit) RRX_C(bits(N) x, bit carry_in)
    result = carry_in : x<N-1:1>;
    carry_out = x<0>;
    return (result, carry_out);
```

Library pseudocode for aarch32/functions/common/SRType

```
enumeration SRType {SRType_LSL, SRType_LSR, SRType_ASR, SRType_ROR, SRType_RRX};
```

Library pseudocode for aarch32/functions/common/Shift

```
// Shift()
// =======

bits(N) Shift(bits(N) value, SRType srtype, integer amount, bit carry_in)
    (result, -) = Shift_C(value, srtype, amount, carry_in);
    return result;
```

Library pseudocode for aarch32/functions/common/Shift_C

```
// Shift_C()
// =========

(bits(N), bit) Shift_C(bits(N) value, SRType srtype, integer amount, bit carry_in)
    assert !(srtype == SRType_RRX && amount != 1);

    if amount == 0 then
        (result, carry_out) = (value, carry_in);
    else
        case srtype of
            when SRType_LSL
                (result, carry_out) = LSL_C(value, amount);
            when SRType_LSR
                (result, carry_out) = LSR_C(value, amount);
            when SRType_ASR
                (result, carry_out) = ASR_C(value, amount);
            when SRType_ROR
                (result, carry_out) = ROR_C(value, amount);
            when SRType_RRX
                (result, carry_out) = RRX_C(value, carry_in);

    return (result, carry_out);
```

Library pseudocode for aarch32/functions/common/T32ExpandImm

```
// T32ExpandImm()
// ==============

bits(32) T32ExpandImm(bits(12) imm12)

    // PSTATE.C argument to following function call does not affect the imm32 result.
    (imm32, -) = T32ExpandImm_C(imm12, PSTATE.C);

    return imm32;
```

Library pseudocode for aarch32/functions/common/T32ExpandImm_C

```
// T32ExpandImm_C()
// ================

(bits(32), bit) T32ExpandImm_C(bits(12) imm12, bit carry_in)

    if imm12<11:10> == '00' then
        case imm12<9:8> of
            when '00'
                imm32 = ZeroExtend(imm12<7:0>, 32);
            when '01'
                imm32 = '00000000' : imm12<7:0> : '00000000' : imm12<7:0>;
            when '10'
                imm32 = imm12<7:0> : '00000000' : imm12<7:0> : '00000000';
            when '11'
                imm32 = imm12<7:0> : imm12<7:0> : imm12<7:0> : imm12<7:0>;
        carry_out = carry_in;
    else
        unrotated_value = ZeroExtend('1':imm12<6:0>, 32);
        (imm32, carry_out) = ROR_C(unrotated_value, UInt(imm12<11:7>));

    return (imm32, carry_out);
```

Library pseudocode for aarch32/functions/coproc/AArch32.CheckCP15InstrCoarseTraps

```
// AArch32.CheckCP15InstrCoarseTraps()
// ===================================
// Check for coarse-grained CP15 traps in HSTR and HCR.

boolean AArch32.CheckCP15InstrCoarseTraps(integer CRn, integer nreg, integer CRm)

    // Check for coarse-grained Hyp traps
    if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then
        if PSTATE.EL == EL0 && !ELUsingAArch32(EL2) then
            return AArch64.CheckCP15InstrCoarseTraps(CRn, nreg, CRm);
        // Check for MCR, MRC, MCRR and MRRC disabled by HSTR<CRn/CRm>
        major = if nreg == 1 then CRn else CRm;
        if !(major IN {4,14}) && HSTR<major> == '1' then
            return TRUE;

        // Check for MRC and MCR disabled by HCR.TIDCP
        if (HCR.TIDCP == '1' && nreg == 1 &&
            ((CRn == 9  && CRm IN {0,1,2,    5,6,7,8   }) ||
             (CRn == 10 && CRm IN {0,1,    4,      8   }) ||
             (CRn == 11 && CRm IN {0,1,2,3,4,5,6,7,8,15}))) then
            return TRUE;

    return FALSE;
```

Library pseudocode for aarch32/functions/exclusive/AArch32.ExclusiveMonitorsPass

```
// AArch32.ExclusiveMonitorsPass()
// ===============================

// Return TRUE if the Exclusives monitors for the current PE include all of the addresses
// associated with the virtual address region of size bytes starting at address.
// The immediately following memory write must be to the same addresses.

boolean AArch32.ExclusiveMonitorsPass(bits(32) address, integer size)

    // It is IMPLEMENTATION DEFINED whether the detection of memory aborts happens
    // before or after the check on the local Exclusives monitor. As a result a failure
    // of the local monitor can occur on some implementations even if the memory
    // access would give an memory abort.

    acctype = AccType_ATOMIC;
    iswrite = TRUE;

    aligned = aligned = (address == (address, size));

    if !aligned then
        secondstage = FALSE;
        AArch32.Abort(address, AArch32.AlignmentFaultAArch32.CheckAlignmentAlign(address, size, acctype,
(acctype, iswrite, secondstage));

    passed = AArch32.IsExclusiveVA(address, ProcessorID(), size);
    if !passed then
        return FALSE;
    memaddrdesc = AArch32.TranslateAddress(address, acctype, iswrite, aligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch32.Abort(address, memaddrdesc.fault);

    passed = IsExclusiveLocal(memaddrdesc.paddress, ProcessorID(), size);(), size);

    if passed then
    ClearExclusiveLocal(ProcessorID());

    if passed then
        if memaddrdesc.memattrs.shareable then
            passed = IsExclusiveGlobal(memaddrdesc.paddress, ProcessorID(), size);

    return passed;
```

Library pseudocode for aarch32/functions/exclusive/AArch32.IsExclusiveVA

```
// An optional IMPLEMENTATION DEFINED test for an exclusive access to a virtual
// address region of size bytes starting at address.
//
// It is permitted (but not required) for this function to return FALSE and
// cause a store exclusive to fail if the virtual address region is not
// totally included within the region recorded by MarkExclusiveVA().
//
// It is always safe to return TRUE which will check the physical address only.
boolean AArch32.IsExclusiveVA(bits(32) address, integer processorid, integer size);
```

Library pseudocode for aarch32/functions/exclusive/AArch32.MarkExclusiveVA

```
// Optionally record an exclusive access to the virtual address region of size bytes
// starting at address for processorid.
AArch32.MarkExclusiveVA(bits(32) address, integer processorid, integer size);
```

Library pseudocode for aarch32/functions/exclusive/AArch32.SetExclusiveMonitors

```
// AArch32.SetExclusiveMonitors()
// ==============================

// Sets the Exclusives monitors for the current PE to record the addresses associated
// with the virtual address region of size bytes starting at address.

AArch32.SetExclusiveMonitors(bits(32) address, integer size)

    acctype = AccType_ATOMIC;
    iswrite = FALSE;
    aligned = (address == Align(address, size));
    memaddrdesc = AArch32.TranslateAddress(address, acctype, iswrite, aligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        return;

    if memaddrdesc.memattrs.shareable then
        MarkExclusiveGlobal(memaddrdesc.paddress, ProcessorID(), size);

    MarkExclusiveLocal(memaddrdesc.paddress, ProcessorID(), size);

    AArch32.MarkExclusiveVA(address, ProcessorID(), size);
```

Library pseudocode for aarch32/functions/float/CheckAdvSIMDEnabled

```
// CheckAdvSIMDEnabled()
// =====================

CheckAdvSIMDEnabled()

    fpexc_check = TRUE;
    advsimd = TRUE;

    AArch32.CheckAdvSIMDOrFPEnabled(fpexc_check, advsimd);
    // Return from CheckAdvSIMDOrFPEnabled() occurs only if Advanced SIMD access is permitted

    // Make temporary copy of D registers
    // _Dclone[] is used as input data for instruction pseudocode
    for i = 0 to 31
        _Dclone[i] = D[i];

    return;
```

Library pseudocode for aarch32/functions/float/CheckAdvSIMDOrVFPEnabled

```
// CheckAdvSIMDOrVFPEnabled()
// ==========================

CheckAdvSIMDOrVFPEnabled(boolean include_fpexc_check, boolean advsimd)
    AArch32.CheckAdvSIMDOrFPEnabled(include_fpexc_check, advsimd);
    // Return from CheckAdvSIMDOrFPEnabled() occurs only if VFP access is permitted
    return;
```

Library pseudocode for aarch32/functions/float/CheckCryptoEnabled32

```
// CheckCryptoEnabled32()
// ======================

CheckCryptoEnabled32()
    CheckAdvSIMDEnabled();
    // Return from CheckAdvSIMDEnabled() occurs only if access is permitted
    return;
```

Library pseudocode for aarch32/functions/float/CheckVFPEnabled

```
// CheckVFPEnabled()
// =================

CheckVFPEnabled(boolean include_fpexc_check)
    advsimd = FALSE;
    AArch32.CheckAdvSIMDOrFPEnabled(include_fpexc_check, advsimd);
    // Return from CheckAdvSIMDOrFPEnabled() occurs only if VFP access is permitted
    return;
```

Library pseudocode for aarch32/functions/float/FPHalvedSub

```
// FPHalvedSub()
// =============

bits(N) FPHalvedSub(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    rounding = FPRoundingMode(fpcr);
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);  inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);     zero2 = (type2 == FPType_Zero);
        if inf1 && inf2 && sign1 == sign2 then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);
        elsif (inf1 && sign1 == '0') || (inf2 && sign2 == '1') then
            result = FPInfinity('0');
        elsif (inf1 && sign1 == '1') || (inf2 && sign2 == '0') then
            result = FPInfinity('1');
        elsif zero1 && zero2 && sign1 != sign2 then
            result = FPZero(sign1);
        else
            result_value = (value1 - value2) / 2.0;
            if result_value == 0.0 then  // Sign of exact zero result depends on rounding mode
                result_sign = if rounding == FPRounding_NEGINF then '1' else '0';
                result = FPZero(result_sign);
            else
                result = FPRound(result_value, fpcr);
    return result;
```

Library pseudocode for aarch32/functions/float/FPRSqrtStep

```
// FPRSqrtStep()
// =============

bits(N) FPRSqrtStep(bits(N) op1, bits(N) op2)
    assert N IN {16,32};
    FPCRType fpcr = StandardFPSCRValue();
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);  inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);     zero2 = (type2 == FPType_Zero);
        bits(N) product;
        if (inf1 && zero2) || (zero1 && inf2) then
            product = FPZero('0');
        else
            product = FPMul(op1, op2, fpcr);
        bits(N) three = FPThree('0');
        result = FPHalvedSub(three, product, fpcr);
    return result;
```

Library pseudocode for aarch32/functions/float/FPRecipStep

```
// FPRecipStep()
// =============

bits(N) FPRecipStep(bits(N) op1, bits(N) op2)
    assert N IN {16,32};
    FPCRType fpcr = StandardFPSCRValue();
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);  inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);     zero2 = (type2 == FPType_Zero);
        bits(N) product;
        if (inf1 && zero2) || (zero1 && inf2) then
            product = FPZero('0');
        else
            product = FPMul(op1, op2, fpcr);
        bits(N) two = FPTwo('0');
        result = FPSub(two, product, fpcr);
    return result;
```

Library pseudocode for aarch32/functions/float/StandardFPSCRValue

```
// StandardFPSCRValue()
// ====================

FPCRType StandardFPSCRValue()
    return '00000' : FPSCR.AHP : '110000' : FPSCR.FZ16 : '0000000000000000000';
```

Library pseudocode for aarch32/functions/memory/AArch32.CheckAlignment

```
// AArch32.CheckAlignment()
// ========================

boolean AArch32.CheckAlignment(bits(32) address, integer alignment, AccType acctype,
                               boolean iswrite)

    if PSTATE.EL == EL0 && !ELUsingAArch32(S1TranslationRegime()) then
        A = SCTLR[].A; //use AArch64 register, when higher Exception level is using AArch64
    elsif PSTATE.EL == EL2 then
        A = HSCTLR.A;
    else
        A = SCTLR.A;
    aligned = (address == Align(address, alignment));
    atomic  = acctype IN { AccType_ATOMIC, AccType_ATOMICRW, AccType_ORDEREDATOMIC, AccType_ORDEREDATOMIC
    ordered = acctype IN { AccType_ORDERED, AccType_ORDEREDRW, AccType_LIMITEDORDERED, AccType_ORDEREDATO
    vector  = acctype == AccType_VEC;

    // AccType_VEC is used for SIMD element alignment checks only
    check = (atomic || ordered || vector || A == '1');

    if check && !aligned then
        secondstage = FALSE;
        AArch32.Abort(address, AArch32.AlignmentFault(acctype, iswrite, secondstage));

    return aligned;
```

Library pseudocode for aarch32/functions/memory/AArch32.MemSingle

```
// AArch32.MemSingle[] - non-assignment (read) form
// ================================================
// Perform an atomic, little-endian read of 'size' bytes.

bits(size*8) AArch32.MemSingle[bits(32) address, integer size, AccType acctype, boolean wasaligned]
    assert size IN {1, 2, 4, 8, 16};
    assert address == Align(address, size);

    AddressDescriptor memaddrdesc;
    bits(size*8) value;
    iswrite = FALSE;

    // MMU or MPU
    memaddrdesc = AArch32.TranslateAddress(address, acctype, iswrite, wasaligned, size);
    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch32.Abort(address, memaddrdesc.fault);

    // Memory array access
    transactional = TSTATE.depth > 0 && !(acctype IN {AccType_IFETCH,AccType_PTW});
    accdesc =     accdesc = CreateAccessDescriptor(acctype, transactional);
    if CreateAccessDescriptor(acctype, transactional);
    if HaveMTEExt() then
        if AArch64.AccessIsTagChecked(ZeroExtend(address, 64), acctype) then
            bits(4) ptag = AArch64.PhysicalTagAArch64.TransformTag(ZeroExtend(address, 64));
            if !AArch64.CheckTag(memaddrdesc, ptag, iswrite) then
                AArch64.TagCheckFail(ZeroExtend(address, 64), iswrite);
    value = _Mem[memaddrdesc, size, accdesc];
    return value;

// AArch32.MemSingle[] - assignment (write) form
// =============================================
// Perform an atomic, little-endian write of 'size' bytes.

AArch32.MemSingle[bits(32) address, integer size, AccType acctype, boolean wasaligned] = bits(size*8) val
    assert size IN {1, 2, 4, 8, 16};
    assert address == Align(address, size);

    AddressDescriptor memaddrdesc;
    iswrite = TRUE;

    // MMU or MPU
    memaddrdesc = AArch32.TranslateAddress(address, acctype, iswrite, wasaligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch32.Abort(address, memaddrdesc.fault);

    // Effect on exclusives
    if memaddrdesc.memattrs.shareable then
        ClearExclusiveByAddress(memaddrdesc.paddress, ProcessorID(), size);

    // Memory array access
    transactional = TSTATE.depth > 0;
    accdesc =     accdesc = CreateAccessDescriptor(acctype, transactional);
    if CreateAccessDescriptor(acctype, transactional);
    if HaveMTEExt() then
        if AArch64.AccessIsTagChecked(ZeroExtend(address, 64), acctype) then
            bits(4) ptag = AArch64.PhysicalTagAArch64.TransformTag(ZeroExtend(address, 64));
            if !AArch64.CheckTag(memaddrdesc, ptag, iswrite) then
                AArch64.TagCheckFail(ZeroExtend(address, 64), iswrite);
    _Mem[memaddrdesc, size, accdesc] = value;
    return;
```

Library pseudocode for aarch32/functions/memory/Hint_PreloadData

```
Hint_PreloadData(bits(32) address);
```

Library pseudocode for aarch32/functions/memory/Hint_PreloadDataForWrite

```
Hint_PreloadDataForWrite(bits(32) address);
```

Library pseudocode for aarch32/functions/memory/Hint_PreloadInstr

```
Hint_PreloadInstr(bits(32) address);
```

Library pseudocode for aarch32/functions/memory/MemA

```
// MemA[] - non-assignment form
// ============================

bits(8*size) MemA[bits(32) address, integer size]
    acctype = AccType_ATOMIC;
    return Mem_with_type[address, size, acctype];

// MemA[] - assignment form
// ========================

MemA[bits(32) address, integer size] = bits(8*size) value
    acctype = AccType_ATOMIC;
    Mem_with_type[address, size, acctype] = value;
    return;
```

Library pseudocode for aarch32/functions/memory/MemO

```
// MemO[] - non-assignment form
// ============================

bits(8*size) MemO[bits(32) address, integer size]
    acctype = AccType_ORDERED;
    return Mem_with_type[address, size, acctype];

// MemO[] - assignment form
// ========================

MemO[bits(32) address, integer size] = bits(8*size) value
    acctype = AccType_ORDERED;
    Mem_with_type[address, size, acctype] = value;
    return;
```

Library pseudocode for aarch32/functions/memory/MemU

```
// MemU[] - non-assignment form
// ============================

bits(8*size) MemU[bits(32) address, integer size]
    acctype = AccType_NORMAL;
    return Mem_with_type[address, size, acctype];

// MemU[] - assignment form
// ========================

MemU[bits(32) address, integer size] = bits(8*size) value
    acctype = AccType_NORMAL;
    Mem_with_type[address, size, acctype] = value;
    return;
```

Library pseudocode for aarch32/functions/memory/MemU_unpriv

```
// MemU_unpriv[] - non-assignment form
// ===================================

bits(8*size) MemU_unpriv[bits(32) address, integer size]
    acctype = AccType_UNPRIV;
    return Mem_with_type[address, size, acctype];

// MemU_unpriv[] - assignment form
// ===============================

MemU_unpriv[bits(32) address, integer size] = bits(8*size) value
    acctype = AccType_UNPRIV;
    Mem_with_type[address, size, acctype] = value;
    return;
```

Library pseudocode for aarch32/functions/memory/Mem_with_type

```
// Mem_with_type[] - non-assignment (read) form
// ============================================
// Perform a read of 'size' bytes. The access byte order is reversed for a big-endian access.
// Instruction fetches would call AArch32.MemSingle directly.

bits(size*8) Mem_with_type[bits(32) address, integer size, AccType acctype]
    assert size IN {1, 2, 4, 8, 16};
    bits(size*8) value;
    boolean iswrite = FALSE;

    aligned = AArch32.CheckAlignment(address, size, acctype, iswrite);
    if !aligned then
        assert size > 1;
        value<7:0> = AArch32.MemSingle[address, 1, acctype, aligned];

        // For subsequent bytes it is CONSTRAINED UNPREDICTABLE whether an unaligned Device memory
        // access will generate an Alignment Fault, as to get this far means the first byte did
        // not, so we must be changing to a new translation page.
        c = ConstrainUnpredictable(Unpredictable_DEVPAGE2);
        assert c IN {Constraint_FAULT, Constraint_NONE};
        if c == Constraint_NONE then aligned = TRUE;

        for i = 1 to size-1
            value<8*i+7:8*i> = AArch32.MemSingle[address+i, 1, acctype, aligned];
    else
        value = AArch32.MemSingle[address, size, acctype, aligned];

    if BigEndian() then
        value = BigEndianReverse(value);
    return value;

// Mem_with_type[] - assignment (write) form
// =========================================
// Perform a write of 'size' bytes. The byte order is reversed for a big-endian access.

Mem_with_type[bits(32) address, integer size, AccType acctype] = bits(size*8) value
    boolean iswrite = TRUE;

    if BigEndian() then
        value = BigEndianReverse(value);

    aligned = AArch32.CheckAlignment(address, size, acctype, iswrite);

    if !aligned then
        assert size > 1;
        AArch32.MemSingle[address, 1, acctype, aligned] = value<7:0>;

        // For subsequent bytes it is CONSTRAINED UNPREDICTABLE whether an unaligned Device memory
        // access will generate an Alignment Fault, as to get this far means the first byte did
        // not, so we must be changing to a new translation page.
        c = ConstrainUnpredictable(Unpredictable_DEVPAGE2);
        assert c IN {Constraint_FAULT, Constraint_NONE};
        if c == Constraint_NONE then aligned = TRUE;

        for i = 1 to size-1
            AArch32.MemSingle[address+i, 1, acctype, aligned] = value<8*i+7:8*i>;
    else
        AArch32.MemSingle[address, size, acctype, aligned] = value;
    return;
```

Library pseudocode for aarch32/functions/ras/AArch32.ESBOperation

```
// AArch32.ESBOperation()
// ======================
// Perform the AArch32 ESB operation for ESB executed in AArch32 state

AArch32.ESBOperation()

    // Check if routed to AArch64 state
    route_to_aarch64 = PSTATE.EL == EL0 && !ELUsingAArch32(EL1);
    if !route_to_aarch64 && EL2Enabled() && !ELUsingAArch32(EL2) then
        route_to_aarch64 = HCR_EL2.TGE == '1' || HCR_EL2.AMO == '1';
    if !route_to_aarch64 && HaveEL(EL3) && !ELUsingAArch32(EL3) then
        route_to_aarch64 = SCR_EL3.EA == '1';

    if route_to_aarch64 then
        AArch64.ESBOperation();
        return;

    route_to_monitor = HaveEL(EL3) && ELUsingAArch32(EL3) && SCR.EA == '1';
    route_to_hyp = PSTATE.EL IN {EL0, EL1} && EL2Enabled() && (HCR.TGE == '1' || HCR.AMO == '1');

    if route_to_monitor then
        target = M32_Monitor;
    elsif route_to_hyp || PSTATE.M == M32_Hyp then
        target = M32_Hyp;
    else
        target = M32_Abort;

    if IsSecure() then
        mask_active = TRUE;
    elsif target == M32_Monitor then
        mask_active = SCR.AW == '1' && (!HaveEL(EL2) || (HCR.TGE == '0' && HCR.AMO == '0'));
    else
        mask_active = target == M32_Abort || PSTATE.M == M32_Hyp;

    mask_set = PSTATE.A == '1';
    (-, el)  = ELFromM32(target);
    intdis   = Halted() || ExternalDebugInterruptsDisabled(el);
    masked   = intdis || (mask_active && mask_set);

    // Check for a masked Physical SError pending
    if IsPhysicalSErrorPending() && masked then
        syndrome32 = AArch32.PhysicalSErrorSyndrome();
        DISR = AArch32.ReportDeferredSError(syndrome32.AET, syndrome32.ExT);
        ClearPendingPhysicalSError();

    return;
```

Library pseudocode for aarch32/functions/ras/AArch32.PhysicalSErrorSyndrome

```
// Return the SError syndrome
AArch32.SErrorSyndrome AArch32.PhysicalSErrorSyndrome();
```

Library pseudocode for aarch32/functions/ras/AArch32.ReportDeferredSError

```
// AArch32.ReportDeferredSError()
// ==============================
// Return deferred SError syndrome

bits(32) AArch32.ReportDeferredSError(bits(2) AET, bit ExT)
    bits(32) target;
    target<31> = '1';                       // A
    syndrome = Zeros(16);
    if PSTATE.EL == EL2 then
        syndrome<11:10> = AET;              // AET
        syndrome<9>     = ExT;              // EA
        syndrome<5:0>   = '010001';         // DFSC
    else
        syndrome<15:14> = AET;              // AET
        syndrome<12>    = ExT;              // ExT
        syndrome<9>     = TTBCR.EAE;        // LPAE
        if TTBCR.EAE == '1' then            // Long-descriptor format
            syndrome<5:0>    = '010001';    // STATUS
        else                                // Short-descriptor format
            syndrome<10,3:0> = '10110';     // FS
    if HaveAnyAArch64() then
        target<24:0> = ZeroExtend(syndrome);// Any RES0 fields must be set to zero
    else
        target<15:0> = syndrome;
    return target;
```

Library pseudocode for aarch32/functions/ras/AArch32.SErrorSyndrome

```
type AArch32.SErrorSyndrome is (
    bits(2) AET,
    bit ExT
)
```

Library pseudocode for aarch32/functions/ras/AArch32.vESBOperation

```
// AArch32.vESBOperation()
// =======================
// Perform the ESB operation for virtual SError interrupts executed in AArch32 state

AArch32.vESBOperation()
    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();

    // Check for EL2 using AArch64 state
    if !ELUsingAArch32(EL2) then
        AArch64.vESBOperation();
        return;

    // If physical SError interrupts are routed to Hyp mode, and TGE is not set, then a
    // virtual SError interrupt might be pending
    vSEI_enabled = HCR.TGE == '0' && HCR.AMO == '1';
    vSEI_pending = vSEI_enabled && HCR.VA == '1';
    vintdis      = Halted() || ExternalDebugInterruptsDisabled(EL1);
    vmasked      = vintdis || PSTATE.A == '1';

    // Check for a masked virtual SError pending
    if vSEI_pending && vmasked then
        VDISR = AArch32.ReportDeferredSError(VDFSR<15:14>, VDFSR<12>);
        HCR.VA = '0';                       // Clear pending virtual SError

    return;
```

Library pseudocode for aarch32/functions/registers/AArch32.ResetGeneralRegisters

```
// AArch32.ResetGeneralRegisters()
// ===============================

AArch32.ResetGeneralRegisters()

    for i = 0 to 7
        R[i] = bits(32) UNKNOWN;
    for i = 8 to 12
        Rmode[i, M32_User] = bits(32) UNKNOWN;
        Rmode[i, M32_FIQ] = bits(32) UNKNOWN;
    if HaveEL(EL2) then Rmode[13, M32_Hyp] = bits(32) UNKNOWN;   // No R14_hyp
    for i = 13 to 14
        Rmode[i, M32_User] = bits(32) UNKNOWN;
        Rmode[i, M32_FIQ] = bits(32) UNKNOWN;
        Rmode[i, M32_IRQ] = bits(32) UNKNOWN;
        Rmode[i, M32_Svc] = bits(32) UNKNOWN;
        Rmode[i, M32_Abort] = bits(32) UNKNOWN;
        Rmode[i, M32_Undef] = bits(32) UNKNOWN;
        if HaveEL(EL3) then Rmode[i, M32_Monitor] = bits(32) UNKNOWN;

    return;
```

Library pseudocode for aarch32/functions/registers/AArch32.ResetSIMDFPRegisters

```
// AArch32.ResetSIMDFPRegisters()
// ==============================

AArch32.ResetSIMDFPRegisters()

    for i = 0 to 15
        Q[i] = bits(128) UNKNOWN;

    return;
```

Library pseudocode for aarch32/functions/registers/AArch32.ResetSpecialRegisters

```
// AArch32.ResetSpecialRegisters()
// ===============================

AArch32.ResetSpecialRegisters()

    // AArch32 special registers
    SPSR_fiq = bits(32) UNKNOWN;
    SPSR_irq = bits(32) UNKNOWN;
    SPSR_svc = bits(32) UNKNOWN;
    SPSR_abt = bits(32) UNKNOWN;
    SPSR_und = bits(32) UNKNOWN;
    if HaveEL(EL2) then
        SPSR_hyp = bits(32) UNKNOWN;
        ELR_hyp = bits(32) UNKNOWN;
    if HaveEL(EL3) then
        SPSR_mon = bits(32) UNKNOWN;

    // External debug special registers
    DLR = bits(32) UNKNOWN;
    DSPSR = bits(32) UNKNOWN;

    return;
```

Library pseudocode for aarch32/functions/registers/AArch32.ResetSystemRegisters

```
AArch32.ResetSystemRegisters(boolean cold_reset);
```

Library pseudocode for aarch32/functions/registers/ALUExceptionReturn

```
// ALUExceptionReturn()
// ====================

ALUExceptionReturn(bits(32) address)
    if PSTATE.EL == EL2 then
        UNDEFINED;
    elsif PSTATE.M IN {M32_User,M32_System} then
        UNPREDICTABLE;          // UNDEFINED or NOP
    else
        AArch32.ExceptionReturn(address, SPSR[]);
```

Library pseudocode for aarch32/functions/registers/ALUWritePC

```
// ALUWritePC()
// ============

ALUWritePC(bits(32) address)
    if CurrentInstrSet() == InstrSet_A32 then
        BXWritePC(address, BranchType_INDIR);
    else
        BranchWritePC(address, BranchType_INDIR);
```

Library pseudocode for aarch32/functions/registers/BXWritePC

```
// BXWritePC()
// ===========

BXWritePC(bits(32) address, BranchType branch_type)
    if address<0> == '1' then
        SelectInstrSet(InstrSet_T32);
        address<0> = '0';
    else
        SelectInstrSet(InstrSet_A32);
        // For branches to an unaligned PC counter in A32 state, the processor takes the branch
        // and does one of:
        // * Forces the address to be aligned
        // * Leaves the PC unaligned, meaning the target generates a PC Alignment fault.
        if address<1> == '1' && ConstrainUnpredictableBool(Unpredictable_A32FORCEALIGNPC) then
            address<1> = '0';
    BranchTo(address, branch_type);
```

Library pseudocode for aarch32/functions/registers/BranchWritePC

```
// BranchWritePC()
// ===============

BranchWritePC(bits(32) address, BranchType branch_type)
    if CurrentInstrSet() == InstrSet_A32 then
        address<1:0> = '00';
    else
        address<0> = '0';
    BranchTo(address, branch_type);
```

Library pseudocode for aarch32/functions/registers/D

```
// D[] - non-assignment form
// =========================

bits(64) D[integer n]
    assert n >= 0 && n <= 31;
    base = (n MOD 2) * 64;
    bits(128) vreg = V[n DIV 2];
    return vreg<base+63:base>;

// D[] - assignment form
// =====================

D[integer n] = bits(64) value
    assert n >= 0 && n <= 31;
    base = (n MOD 2) * 64;
    bits(128) vreg = V[n DIV 2];
    vreg<base+63:base> = value;
    V[n DIV 2] = vreg;
    return;
```

Library pseudocode for aarch32/functions/registers/Din

```
// Din[] - non-assignment form
// ===========================

bits(64) Din[integer n]
    assert n >= 0 && n <= 31;
    return _Dclone[n];
```

Library pseudocode for aarch32/functions/registers/LR

```
// LR - assignment form
// ====================

LR = bits(32) value
    R[14] = value;
    return;

// LR - non-assignment form
// ========================

bits(32) LR
    return R[14];
```

Library pseudocode for aarch32/functions/registers/LoadWritePC

```
// LoadWritePC()
// =============

LoadWritePC(bits(32) address)
    BXWritePC(address, BranchType_INDIR);
```

Library pseudocode for aarch32/functions/registers/LookUpRIndex

```
// LookUpRIndex()
// ==============

integer LookUpRIndex(integer n, bits(5) mode)
    assert n >= 0 && n <= 14;

    case n of  // Select  index by mode:     usr fiq irq svc abt und hyp
        when 8     result = RBankSelect(mode,  8, 24,  8,  8,  8,  8,  8);
        when 9     result = RBankSelect(mode,  9, 25,  9,  9,  9,  9,  9);
        when 10    result = RBankSelect(mode, 10, 26, 10, 10, 10, 10, 10);
        when 11    result = RBankSelect(mode, 11, 27, 11, 11, 11, 11, 11);
        when 12    result = RBankSelect(mode, 12, 28, 12, 12, 12, 12, 12);
        when 13    result = RBankSelect(mode, 13, 29, 17, 19, 21, 23, 15);
        when 14    result = RBankSelect(mode, 14, 30, 16, 18, 20, 22, 14);
        otherwise  result = n;

    return result;
```

Library pseudocode for aarch32/functions/registers/Monitor_mode_registers

```
bits(32) SP_mon;
bits(32) LR_mon;
```

Library pseudocode for aarch32/functions/registers/PC

```
// PC - non-assignment form
// ========================

bits(32) PC
    return R[15];               // This includes the offset from AArch32 state
```

Library pseudocode for aarch32/functions/registers/PCStoreValue

```
// PCStoreValue()
// ==============

bits(32) PCStoreValue()
    // This function returns the PC value. On architecture versions before Armv7, it
    // is permitted to instead return PC+4, provided it does so consistently. It is
    // used only to describe A32 instructions, so it returns the address of the current
    // instruction plus 8 (normally) or 12 (when the alternative is permitted).
    return PC;
```

Library pseudocode for aarch32/functions/registers/Q

```
// Q[] - non-assignment form
// =========================

bits(128) Q[integer n]
    assert n >= 0 && n <= 15;
    return V[n];

// Q[] - assignment form
// =====================

Q[integer n] = bits(128) value
    assert n >= 0 && n <= 15;
    V[n] = value;
    return;
```

Library pseudocode for aarch32/functions/registers/Qin

```
// Qin[] - non-assignment form
// ===========================

bits(128) Qin[integer n]
    assert n >= 0 && n <= 15;
    return Din[2*n+1]:Din[2*n];
```

Library pseudocode for aarch32/functions/registers/R

```
// R[] - assignment form
// =====================

R[integer n] = bits(32) value
    Rmode[n, PSTATE.M] = value;
    return;

// R[] - non-assignment form
// =========================

bits(32) R[integer n]
    if n == 15 then
        offset = (if CurrentInstrSet() == InstrSet_A32 then 8 else 4);
        return _PC<31:0> + offset;
    else
        return Rmode[n, PSTATE.M];
```

Library pseudocode for aarch32/functions/registers/RBankSelect

```
// RBankSelect()
// =============

integer RBankSelect(bits(5) mode, integer usr, integer fiq, integer irq,
                    integer svc, integer abt, integer und, integer hyp)

    case mode of
        when M32_User    result = usr;  // User mode
        when M32_FIQ     result = fiq;  // FIQ mode
        when M32_IRQ     result = irq;  // IRQ mode
        when M32_Svc     result = svc;  // Supervisor mode
        when M32_Abort   result = abt;  // Abort mode
        when M32_Hyp     result = hyp;  // Hyp mode
        when M32_Undef   result = und;  // Undefined mode
        when M32_System  result = usr;  // System mode uses User mode registers
        otherwise        Unreachable(); // Monitor mode

    return result;
```

Library pseudocode for aarch32/functions/registers/Rmode

```
// Rmode[] - non-assignment form
// =============================

bits(32) Rmode[integer n, bits(5) mode]
    assert n >= 0 && n <= 14;

    // Check for attempted use of Monitor mode in Non-secure state.
    if !IsSecure() then assert mode != M32_Monitor;
    assert !BadMode(mode);

    if mode == M32_Monitor then
        if n == 13 then return SP_mon;
        elsif n == 14 then return LR_mon;
        else return _R[n]<31:0>;
    else
        return _R[LookUpRIndex(n, mode)]<31:0>;

// Rmode[] - assignment form
// =========================

Rmode[integer n, bits(5) mode] = bits(32) value
    assert n >= 0 && n <= 14;

    // Check for attempted use of Monitor mode in Non-secure state.
    if !IsSecure() then assert mode != M32_Monitor;
    assert !BadMode(mode);

    if mode == M32_Monitor then
        if n == 13 then SP_mon = value;
        elsif n == 14 then LR_mon = value;
        else _R[n]<31:0> = value;
    else
        // It is CONSTRAINED UNPREDICTABLE whether the upper 32 bits of the X
        // register are unchanged or set to zero. This is also tested for on
        // exception entry, as this applies to all AArch32 registers.
        if !HighestELUsingAArch32() && ConstrainUnpredictableBool(Unpredictable_ZEROUPPER) then
            _R[LookUpRIndex(n, mode)] = ZeroExtend(value);
        else
            _R[LookUpRIndex(n, mode)]<31:0> = value;

    return;
```

Library pseudocode for aarch32/functions/registers/S

```
// S[] - non-assignment form
// =========================

bits(32) S[integer n]
    assert n >= 0 && n <= 31;
    base = (n MOD 4) * 32;
    bits(128) vreg = V[n DIV 4];
    return vreg<base+31:base>;

// S[] - assignment form
// =====================

S[integer n] = bits(32) value
    assert n >= 0 && n <= 31;
    base = (n MOD 4) * 32;
    bits(128) vreg = V[n DIV 4];
    vreg<base+31:base> = value;
    V[n DIV 4] = vreg;
    return;
```

Library pseudocode for aarch32/functions/registers/SP

```
// SP - assignment form
// ====================

SP = bits(32) value
    R[13] = value;
    return;

// SP - non-assignment form
// ========================

bits(32) SP
    return R[13];
```

Library pseudocode for aarch32/functions/registers/_Dclone

```
array bits(64) _Dclone[0..31];
```

Library pseudocode for aarch32/functions/system/AArch32.ExceptionReturn

```
// AArch32.ExceptionReturn()
// =========================

AArch32.ExceptionReturn(bits(32) new_pc, bits(32) spsr)

    SynchronizeContext();

    // Attempts to change to an illegal mode or state will invoke the Illegal Execution state
    // mechanism
    SetPSTATEFromPSR(spsr);
    ClearExclusiveLocal(ProcessorID());
    SendEventLocal();

    if PSTATE.IL == '1' then
        // If the exception return is illegal, PC[1:0] are UNKNOWN
        new_pc<1:0> = bits(2) UNKNOWN;
    else
        // LR[1:0] or LR[0] are treated as being 0, depending on the target instruction set state
        if PSTATE.T == '1' then
            new_pc<0> = '0';                // T32
        else
            new_pc<1:0> = '00';             // A32

    BranchTo(new_pc, BranchType_ERET);
```

Library pseudocode for aarch32/functions/system/AArch32.ExecutingATS1xPInstr

```
// AArch32.ExecutingATS1xPInstr()
// ==============================
// Return TRUE if current instruction is AT S1CPR/WP

boolean AArch32.ExecutingATS1xPInstr()
    if !HavePrivATExt() then return FALSE;

    instr = ThisInstr();
    if instr<24+:4> == '1110' && instr<8+:4> == '1110' then
        op1 = instr<21+:3>;
        CRn = instr<16+:4>;
        CRm = instr<0+:4>;
        op2 = instr<5+:3>;
        return (op1 == '000' && CRn == '0111' && CRm == '1001' && op2 IN {'000','001'});
    else
        return FALSE;
```

Library pseudocode for aarch32/functions/system/AArch32.ExecutingCP10or11Instr

```
// AArch32.ExecutingCP10or11Instr()
// ================================

boolean AArch32.ExecutingCP10or11Instr()
    instr =  ThisInstr();
    instr_set = CurrentInstrSet();
    assert instr_set IN {InstrSet_A32, InstrSet_T32};

    if instr_set == InstrSet_A32 then
        return ((instr<27:24> == '1110' || instr<27:25> == '110') && instr<11:8> == '101x');
    else // InstrSet_T32
        return (instr<31:28> == '111x' && (instr<27:24> == '1110' || instr<27:25> == '110') && instr<11:8
```

Library pseudocode for aarch32/functions/system/AArch32.ExecutingLSMInstr

```
// AArch32.ExecutingLSMInstr()
// ===========================
// Returns TRUE if processor is executing a Load/Store Multiple instruction

boolean AArch32.ExecutingLSMInstr()
    instr =  ThisInstr();
    instr_set = CurrentInstrSet();
    assert instr_set IN {InstrSet_A32, InstrSet_T32};

    if instr_set == InstrSet_A32 then
        return (instr<28+:4> != '1111' && instr<25+:3> == '100');
    else // InstrSet_T32
        if ThisInstrLength() == 16 then
            return (instr<12+:4> == '1100');
        else
            return (instr<25+:7> == '1110100' && instr<22> == '0');
```

Library pseudocode for aarch32/functions/system/AArch32.ITAdvance

```
// AArch32.ITAdvance()
// ===================

AArch32.ITAdvance()
    if PSTATE.IT<2:0> == '000' then
        PSTATE.IT = '00000000';
    else
        PSTATE.IT<4:0> = LSL(PSTATE.IT<4:0>, 1);
    return;
```

Library pseudocode for aarch32/functions/system/AArch32.SysRegRead

```
// Read from a 32-bit AArch32 System register and return the register's contents.
bits(32) AArch32.SysRegRead(integer cp_num, bits(32) instr);
```

Library pseudocode for aarch32/functions/system/AArch32.SysRegRead64

```
// Read from a 64-bit AArch32 System register and return the register's contents.
bits(64) AArch32.SysRegRead64(integer cp_num, bits(32) instr);
```

Library pseudocode for aarch32/functions/system/AArch32.SysRegReadCanWriteAPSR

```
// AArch32.SysRegReadCanWriteAPSR()
// ================================
// Determines whether the AArch32 System register read instruction can write to APSR flags.

boolean AArch32.SysRegReadCanWriteAPSR(integer cp_num, bits(32) instr)
    assert UsingAArch32();
    assert (cp_num IN {14,15});
    assert cp_num == UInt(instr<11:8>);

    opc1 = UInt(instr<23:21>);
    opc2 = UInt(instr<7:5>);
    CRn  = UInt(instr<19:16>);
    CRm  = UInt(instr<3:0>);

    if cp_num == 14 && opc1 == 0 && CRn == 0 && CRm == 1 && opc2 == 0 then // DBGDSCRint
        return TRUE;

    return FALSE;
```

Library pseudocode for aarch32/functions/system/AArch32.SysRegWrite

```
// Write to a 32-bit AArch32 System register.
AArch32.SysRegWrite(integer cp_num, bits(32) instr, bits(32) val);
```

Library pseudocode for aarch32/functions/system/AArch32.SysRegWrite64

```
// Write to a 64-bit AArch32 System register.
AArch32.SysRegWrite64(integer cp_num, bits(32) instr, bits(64) val);
```

Library pseudocode for aarch32/functions/system/AArch32.WriteMode

```
// AArch32.WriteMode()
// ===================
// Function for dealing with writes to PSTATE.M from AArch32 state only.
// This ensures that PSTATE.EL and PSTATE.SP are always valid.

AArch32.WriteMode(bits(5) mode)
    (valid,el) = ELFromM32(mode);
    assert valid;
    PSTATE.M  = mode;
    PSTATE.EL  = el;
    PSTATE.nRW = '1';
    PSTATE.SP  = (if mode IN {M32_User,M32_System} then '0' else '1');
    return;
```

Library pseudocode for aarch32/functions/system/AArch32.WriteModeByInstr

```
// AArch32.WriteModeByInstr()
// ==========================
// Function for dealing with writes to PSTATE.M from an AArch32 instruction, and ensuring that
// illegal state changes are correctly flagged in PSTATE.IL.

AArch32.WriteModeByInstr(bits(5) mode)
    (valid,el) = ELFromM32(mode);

    // 'valid' is set to FALSE if' mode' is invalid for this implementation or the current value
    // of SCR.NS/SCR_EL3.NS. Additionally, it is illegal for an instruction to write 'mode' to
    // PSTATE.EL if it would result in any of:
    // * A change to a mode that would cause entry to a higher Exception level.
    if UInt(el) > UInt(PSTATE.EL) then
        valid = FALSE;

    // * A change to or from Hyp mode.
    if (PSTATE.M == M32_Hyp || mode == M32_Hyp) && PSTATE.M != mode then
        valid = FALSE;

    // * When EL2 is implemented, the value of HCR.TGE is '1', a change to a Non-secure EL1 mode.
    if PSTATE.M == M32_Monitor && HaveEL(EL2) && el == EL1 && SCR.NS == '1' && HCR.TGE == '1' then
        valid = FALSE;

    if !valid then
        PSTATE.IL = '1';
    else
        AArch32.WriteMode(mode);
```

Library pseudocode for aarch32/functions/system/BadMode

```
// BadMode()
// =========

boolean BadMode(bits(5) mode)
    // Return TRUE if 'mode' encodes a mode that is not valid for this implementation
    case mode of
        when M32_Monitor
            valid = HaveAArch32EL(EL3);
        when M32_Hyp
            valid = HaveAArch32EL(EL2);
        when M32_FIQ, M32_IRQ, M32_Svc, M32_Abort, M32_Undef, M32_System
            // If EL3 is implemented and using AArch32, then these modes are EL3 modes in Secure
            // state, and EL1 modes in Non-secure state. If EL3 is not implemented or is using
            // AArch64, then these modes are EL1 modes.
            // Therefore it is sufficient to test this implementation supports EL1 using AArch32.
            valid = HaveAArch32EL(EL1);
        when M32_User
            valid = HaveAArch32EL(EL0);
        otherwise
            valid = FALSE;           // Passed an illegal mode value
    return !valid;
```

Library pseudocode for aarch32/functions/system/BankedRegisterAccessValid

```
// BankedRegisterAccessValid()
// ===========================
// Checks for MRS (Banked register) or MSR (Banked register) accesses to registers
// other than the SPSRs that are invalid. This includes ELR_hyp accesses.

BankedRegisterAccessValid(bits(5) SYSm, bits(5) mode)

    case SYSm of
        when '000xx', '00100'                           // R8_usr to R12_usr
            if mode != M32_FIQ then UNPREDICTABLE;
        when '00101'                                    // SP_usr
            if mode == M32_System then UNPREDICTABLE;
        when '00110'                                    // LR_usr
            if mode IN {M32_Hyp,M32_System} then UNPREDICTABLE;
        when '010xx', '0110x', '01110'                  // R8_fiq to R12_fiq, SP_fiq, LR_fiq
            if mode == M32_FIQ then UNPREDICTABLE;
        when '1000x'                                    // LR_irq, SP_irq
            if mode == M32_IRQ then UNPREDICTABLE;
        when '1001x'                                    // LR_svc, SP_svc
            if mode == M32_Svc then UNPREDICTABLE;
        when '1010x'                                    // LR_abt, SP_abt
            if mode == M32_Abort then UNPREDICTABLE;
        when '1011x'                                    // LR_und, SP_und
            if mode == M32_Undef then UNPREDICTABLE;
        when '1110x'                                    // LR_mon, SP_mon
            if !HaveEL(EL3) || !IsSecure() || mode == M32_Monitor then UNPREDICTABLE;
        when '11110'                                    // ELR_hyp, only from Monitor or Hyp mode
            if !HaveEL(EL2) || !(mode IN {M32_Monitor,M32_Hyp}) then UNPREDICTABLE;
        when '11111'                                    // SP_hyp, only from Monitor mode
            if !HaveEL(EL2) || mode != M32_Monitor then UNPREDICTABLE;
        otherwise
            UNPREDICTABLE;

    return;
```

Library pseudocode for aarch32/functions/system/CPSRWriteByInstr

```
// CPSRWriteByInstr()
// ==================
// Update PSTATE.<N,Z,C,V,Q,GE,E,A,I,F,M> from a CPSR value written by an MSR instruction.

CPSRWriteByInstr(bits(32) value, bits(4) bytemask)
    privileged = PSTATE.EL != EL0;              // PSTATE.<A,I,F,M> are not writable at EL0

    // Write PSTATE from 'value', ignoring bytes masked by 'bytemask'
    if bytemask<3> == '1' then
        PSTATE.<N,Z,C,V,Q> = value<31:27>;
        // Bits <26:24> are ignored

    if bytemask<2> == '1' then
        // Bit <23> is RES0
        if privileged then
            PSTATE.PAN = value<22>;
        // Bits <21:20> are RES0
        PSTATE.GE = value<19:16>;
    if bytemask<1> == '1' then
        // Bits <15:10> are RES0
        PSTATE.E = value<9>;                    // PSTATE.E is writable at EL0
        if privileged then
            PSTATE.A = value<8>;

    if bytemask<0> == '1' then
        if privileged then
            PSTATE.<I,F> = value<7:6>;
            // Bit <5> is RES0
            // AArch32.WriteModeByInstr() sets PSTATE.IL to 1 if this is an illegal mode change.
            AArch32.WriteModeByInstr(value<4:0>);

    return;
```

Library pseudocode for aarch32/functions/system/ConditionPassed

```
// ConditionPassed()
// =================

boolean ConditionPassed()
    return ConditionHolds(AArch32.CurrentCond());
```

Library pseudocode for aarch32/functions/system/CurrentCond

```
bits(4) AArch32.CurrentCond();
```

Library pseudocode for aarch32/functions/system/InITBlock

```
// InITBlock()
// ===========

boolean InITBlock()
    if CurrentInstrSet() == InstrSet_T32 then
        return PSTATE.IT<3:0> != '0000';
    else
        return FALSE;
```

Library pseudocode for aarch32/functions/system/LastInITBlock

```
// LastInITBlock()
// ===============

boolean LastInITBlock()
    return (PSTATE.IT<3:0> == '1000');
```

Library pseudocode for aarch32/functions/system/SPSRWriteByInstr

```
// SPSRWriteByInstr()
// ==================

SPSRWriteByInstr(bits(32) value, bits(4) bytemask)

    new_spsr = SPSR[];

    if bytemask<3> == '1' then
        new_spsr<31:24> = value<31:24>;  // N,Z,C,V,Q flags, IT[1:0],J bits

    if bytemask<2> == '1' then
        new_spsr<23:16> = value<23:16>;  // IL bit, GE[3:0] flags

    if bytemask<1> == '1' then
        new_spsr<15:8> = value<15:8>;    // IT[7:2] bits, E bit, A interrupt mask

    if bytemask<0> == '1' then
        new_spsr<7:0> = value<7:0>;      // I,F interrupt masks, T bit, Mode bits

    SPSR[] = new_spsr;                   // UNPREDICTABLE if User or System mode

    return;
```

Library pseudocode for aarch32/functions/system/SPSRaccessValid

```
// SPSRaccessValid()
// =================
// Checks for MRS (Banked register) or MSR (Banked register) accesses to the SPSRs
// that are UNPREDICTABLE

SPSRaccessValid(bits(5) SYSm, bits(5) mode)
    case SYSm of
        when '01110'                                                    // SPSR_fiq
            if mode == M32_FIQ   then UNPREDICTABLE;
        when '10000'                                                    // SPSR_irq
            if mode == M32_IRQ   then UNPREDICTABLE;
        when '10010'                                                    // SPSR_svc
            if mode == M32_Svc   then UNPREDICTABLE;
        when '10100'                                                    // SPSR_abt
            if mode == M32_Abort then UNPREDICTABLE;
        when '10110'                                                    // SPSR_und
            if mode == M32_Undef then UNPREDICTABLE;
        when '11100'                                                    // SPSR_mon
            if !HaveEL(EL3) || mode == M32_Monitor || !IsSecure() then UNPREDICTABLE;
        when '11110'                                                    // SPSR_hyp
            if !HaveEL(EL2) || mode != M32_Monitor then UNPREDICTABLE;
        otherwise
            UNPREDICTABLE;

    return;
```

Library pseudocode for aarch32/functions/system/SelectInstrSet

```
// SelectInstrSet()
// ================

SelectInstrSet(InstrSet iset)
    assert CurrentInstrSet() IN {InstrSet_A32, InstrSet_T32};
    assert iset IN {InstrSet_A32, InstrSet_T32};

    PSTATE.T = if iset == InstrSet_A32 then '0' else '1';

    return;
```

Library pseudocode for aarch32/functions/v6simd/Sat

```
// Sat()
// =====

bits(N) Sat(integer i, integer N, boolean unsigned)
    result = if unsigned then UnsignedSat(i, N) else SignedSat(i, N);
    return result;
```

Library pseudocode for aarch32/functions/v6simd/SignedSat

```
// SignedSat()
// ===========

bits(N) SignedSat(integer i, integer N)
    (result, -) = SignedSatQ(i, N);
    return result;
```

Library pseudocode for aarch32/functions/v6simd/UnsignedSat

```
// UnsignedSat()
// =============

bits(N) UnsignedSat(integer i, integer N)
    (result, -) = UnsignedSatQ(i, N);
    return result;
```

Library pseudocode for aarch32/translation/attrs/AArch32.DefaultTEXDecode

```
// AArch32.DefaultTEXDecode()
// ==========================

MemoryAttributes AArch32.DefaultTEXDecode(bits(3) TEX, bit C, bit B, bit S, AccType acctype)

    MemoryAttributes mematTrs;

    // Reserved values map to allocated values
    if (TEX == '001' && C:B == '01') || (TEX == '010' && C:B != '00') || TEX == '011' then
        bits(5) texcb;
        (-, texcb) = ConstrainUnpredictableBits(Unpredictable_RESTEXCB);
        TEX = texcb<4:2>;  C = texcb<1>;  B = texcb<0>;

    case TEX:C:B of
        when '00000'
            // Device-nGnRnE
            mematTrs.memtype = MemType_Device;
            mematTrs.device = DeviceType_nGnRnE;
        when '00001', '01000'
            // Device-nGnRE
            mematTrs.memtype = MemType_Device;
            mematTrs.device = DeviceType_nGnRE;
        when '00010', '00011', '00100'
            // Write-back or Write-through Read allocate, or Non-cacheable
            mematTrs.memtype = MemType_Normal;
            mematTrs.inner = ShortConvertAttrsHints(C:B, acctype, FALSE);
            mematTrs.outer = ShortConvertAttrsHints(C:B, acctype, FALSE);
            mematTrs.shareable = (S == '1');
        when '00110'
            mematTrs = MemoryAttributes IMPLEMENTATION_DEFINED;
        when '00111'
            // Write-back Read and Write allocate
            mematTrs.memtype = MemType_Normal;
            mematTrs.inner = ShortConvertAttrsHints('01', acctype, FALSE);
            mematTrs.outer = ShortConvertAttrsHints('01', acctype, FALSE);
            mematTrs.shareable = (S == '1');
        when '1xxxx'
            // Cacheable, TEX<1:0> = Outer attrs, {C,B} = Inner attrs
            mematTrs.memtype = MemType_Normal;
            mematTrs.inner = ShortConvertAttrsHints(C:B, acctype, FALSE);
            mematTrs.outer = ShortConvertAttrsHints(TEX<1:0>, acctype, FALSE);
            mematTrs.shareable = (S == '1');
        otherwise
            // Reserved, handled above
            Unreachable();

    // transient bits are not supported in this format
    mematTrs.inner.transient = FALSE;
    mematTrs.outer.transient = FALSE;

    // distinction between inner and outer shareable is not supported in this format
    mematTrs.outershareable = mematTrs.shareable;
    mematTrs.tagged = FALSE;

    return MemAttrDefaults(mematTrs);
```

Library pseudocode for aarch32/translation/attrs/AArch32.InstructionDevice

```
// AArch32.InstructionDevice()
// ===========================
// Instruction fetches from memory marked as Device but not execute-never might generate a
// Permission Fault but are otherwise treated as if from Normal Non-cacheable memory.

AddressDescriptor AArch32.InstructionDevice(AddressDescriptor addrdesc, bits(32) vaddress,
                                            bits(40) ipaddress, integer level,  bits(4) domain,
                                            AccType acctype, boolean iswrite, boolean secondstage,
                                            boolean s2fs1walk)

    c = ConstrainUnpredictable(Unpredictable_INSTRDEVICE);
    assert c IN {Constraint_NONE, Constraint_FAULT};

    if c == Constraint_FAULT then
        addrdesc.fault = AArch32.PermissionFault(ipaddress,  domain, level, acctype, iswrite,
                                                 secondstage, s2fs1walk);
    else
        addrdesc.mattrs.memtype = MemType_Normal;
        addrdesc.mattrs.inner.attrs = MemAttr_NC;
        addrdesc.mattrs.inner.hints = MemHint_No;
        addrdesc.mattrs.outer = addrdesc.mattrs.inner;
        addrdesc.mattrs.tagged = FALSE;
        addrdesc.mattrs = MemAttrDefaults(addrdesc.mattrs);

    return addrdesc;
```

Library pseudocode for aarch32/translation/attrs/AArch32.RemappedTEXDecode

```
// AArch32.RemappedTEXDecode()
// ===========================

MemoryAttributes AArch32.RemappedTEXDecode(bits(3) TEX, bit C, bit B, bit S, AccType acctype)

    MemoryAttributes mematTRS;

    region = UInt(TEX<0>:C:B);          // TEX<2:1> are ignored in this mapping scheme
    if region == 6 then
        mematTRS = MemoryAttributes IMPLEMENTATION_DEFINED;
    else
        base = 2 * region;
        attrfield = PRRR<base+1:base>;

        if attrfield == '11' then       // Reserved, maps to allocated value
            (-, attrfield) = ConstrainUnpredictableBits(Unpredictable_RESPRRR);

        case attrfield of
            when '00'                   // Device-nGnRnE
                mematTRS.memtype = MemType_Device;
                mematTRS.device = DeviceType_nGnRnE;
            when '01'                   // Device-nGnRE
                mematTRS.memtype = MemType_Device;
                mematTRS.device = DeviceType_nGnRE;
            when '10'
                mematTRS.memtype = MemType_Normal;
                mematTRS.inner = ShortConvertAttrsHints(NMRR<base+1:base>, acctype, FALSE);
                mematTRS.outer = ShortConvertAttrsHints(NMRR<base+17:base+16>, acctype, FALSE);
                s_bit = if S == '0' then PRRR.NS0 else PRRR.NS1;
                mematTRS.shareable = (s_bit == '1');
                mematTRS.outershareable = (s_bit == '1' && PRRR<region+24> == '0');
            when '11'
                Unreachable();

    // transient bits are not supported in this format
    mematTRS.inner.transient = FALSE;
    mematTRS.outer.transient = FALSE;
    mematTRS.tagged = FALSE;

    return MemAttrDefaults(mematTRS);
```

Library pseudocode for aarch32/translation/attrs/AArch32.S1AttrDecode

```
// AArch32.S1AttrDecode()
// ======================
// Converts the Stage 1 attribute fields, using the MAIR, to orthogonal
// attributes and hints.

MemoryAttributes AArch32.S1AttrDecode(bits(2) SH, bits(3) attr, AccType acctype)

    MemoryAttributes mematTrs;

    if PSTATE.EL == EL2 then
        mair = HMAIR1:HMAIR0;
    else
        mair = MAIR1:MAIR0;
    index = 8 * UInt(attr);
    attrfield = mair<index+7:index>;

    mematTrs.tagged = FALSE;
    if ((attrfield<7:4> != '0000' && attrfield<7:4> != '1111' && attrfield<3:0> == '0000') ||
        (attrfield<7:4> == '0000' && attrfield<3:0> != 'xx00')) then
        // Reserved, maps to an allocated value
        (-, attrfield) = ConstrainUnpredictableBits(Unpredictable_RESMAIR);
    if !HaveMTEExt() && attrfield<7:4> == '1111' && attrfield<3:0> == '0000' then
        // Reserved, maps to an allocated value
        (-, attrfield) = ConstrainUnpredictableBits(Unpredictable_RESMAIR);

    if attrfield<7:4> == '0000' then            // Device
        mematTrs.memtype = MemType_Device;
        case attrfield<3:0> of
            when '0000'  mematTrs.device = DeviceType_nGnRnE;
            when '0100'  mematTrs.device = DeviceType_nGnRE;
            when '1000'  mematTrs.device = DeviceType_nGRE;
            when '1100'  mematTrs.device = DeviceType_GRE;
            otherwise    Unreachable();         // Reserved, handled above

    elsif attrfield<3:0> != '0000'  then        // Normal
        mematTrs.memtype = MemType_Normal;
        mematTrs.outer = LongConvertAttrsHints(attrfield<7:4>, acctype);
        mematTrs.inner = LongConvertAttrsHints(attrfield<3:0>, acctype);
        mematTrs.shareable = SH<1> == '1';
        mematTrs.outershareable = SH == '10';
    elsif HaveMTEExt() && attrfield == '11110000' then // Normal, Tagged if WB-RWA
        mematTrs.memtype = MemType_Normal;
        mematTrs.outer = LongConvertAttrsHints('1111', acctype); // WB_RWA
        mematTrs.inner = LongConvertAttrsHints('1111', acctype); // WB_RWA
        mematTrs.shareable = SH<1> == '1';
        mematTrs.outershareable = SH == '10';
        mematTrs.tagged = (mematTrs.inner.attrs == MemAttr_WB &&
                           mematTrs.inner.hints == MemHint_RWA &&
                           mematTrs.outer.attrs == MemAttr_WB &&
                           mematTrs.outer.hints == MemHint_RWA);
    else
        Unreachable();                          // Reserved, handled above

    return MemAttrDefaults(mematTrs);
```

Library pseudocode for aarch32/translation/attrs/AArch32.TranslateAddressS1Off

```
// AArch32.TranslateAddressS1Off()
// ===============================
// Called for stage 1 translations when translation is disabled to supply a default translation.
// Note that there are additional constraints on instruction prefetching that are not described in
// this pseudocode.

TLBRecord AArch32.TranslateAddressS1Off(bits(32) vaddress, AccType acctype, boolean iswrite)
    assert ELUsingAArch32(S1TranslationRegime());

    TLBRecord result;

    default_cacheable = (HasS2Translation() && ((if ELUsingAArch32(EL2) then HCR.DC else HCR_EL2.DC) == '

    if default_cacheable then
        // Use default cacheable settings
        result.addrdesc.memattrs.memtype = MemType_Normal;
        result.addrdesc.memattrs.inner.attrs = MemAttr_WB;      // Write-back
        result.addrdesc.memattrs.inner.hints = MemHint_RWA;
        result.addrdesc.memattrs.shareable = FALSE;
        result.addrdesc.memattrs.outershareable = FALSE;
        result.addrdesc.memattrs.tagged = HCR_EL2.DCT == '1';
    elsif acctype != AccType_IFETCH then
        // Treat data as Device
        result.addrdesc.memattrs.memtype = MemType_Device;
        result.addrdesc.memattrs.device = DeviceType_nGnRnE;
        result.addrdesc.memattrs.inner = MemAttrHints UNKNOWN;
        result.addrdesc.memattrs.tagged = FALSE;
    else
        // Instruction cacheability controlled by SCTLR/HSCTLR.I
        if PSTATE.EL == EL2 then
            cacheable = HSCTLR.I == '1';
        else
            cacheable = SCTLR.I == '1';
        result.addrdesc.memattrs.memtype = MemType_Normal;
        if cacheable then
            result.addrdesc.memattrs.inner.attrs = MemAttr_WT;
            result.addrdesc.memattrs.inner.hints = MemHint_RA;
        else
            result.addrdesc.memattrs.inner.attrs = MemAttr_NC;
            result.addrdesc.memattrs.inner.hints = MemHint_No;
        result.addrdesc.memattrs.shareable = TRUE;
        result.addrdesc.memattrs.outershareable = TRUE;
        result.addrdesc.memattrs.tagged = FALSE;

    result.addrdesc.memattrs.outer = result.addrdesc.memattrs.inner;

    result.addrdesc.memattrs = MemAttrDefaults(result.addrdesc.memattrs);

    result.perms.ap = bits(3) UNKNOWN;
    result.perms.xn = '0';
    result.perms.pxn = '0';

    result.nG = bit UNKNOWN;
    result.contiguous = boolean UNKNOWN;
    result.domain = bits(4) UNKNOWN;
    result.level = integer UNKNOWN;
    result.blocksize = integer UNKNOWN;
    result.addrdesc.paddress.address = ZeroExtend(vaddress);
    result.addrdesc.paddress.NS = if IsSecure() then '0' else '1';
    result.addrdesc.fault = AArch32.NoFault();
    return result;
```

Library pseudocode for aarch32/translation/checks/AArch32.AccessIsPrivileged

```
// AArch32.AccessIsPrivileged()
// ============================

boolean AArch32.AccessIsPrivileged(AccType acctype)

    el = AArch32.AccessUsesEL(acctype);

    if el == EL0 then
        ispriv = FALSE;
    elsif el != EL1 then
        ispriv = TRUE;
    else
        ispriv = (acctype != AccType_UNPRIV);

    return ispriv;
```

Library pseudocode for aarch32/translation/checks/AArch32.AccessUsesEL

```
// AArch32.AccessUsesEL()
// ======================
// Returns the Exception Level of the regime that will manage the translation for a given access type.

bits(2) AArch32.AccessUsesEL(AccType acctype)
    if acctype == AccType_UNPRIV then
        return EL0;
    else
        return PSTATE.EL;
```

Library pseudocode for aarch32/translation/checks/AArch32.CheckDomain

```
// AArch32.CheckDomain()
// =====================

(boolean, FaultRecord) AArch32.CheckDomain(bits(4) domain, bits(32) vaddress, integer level,
                                           AccType acctype, boolean iswrite)

    index = 2 * UInt(domain);
    attrfield = DACR<index+1:index>;

    if attrfield == '10' then          // Reserved, maps to an allocated value
        // Reserved value maps to an allocated value
        (-, attrfield) = ConstrainUnpredictableBits(Unpredictable_RESDACR);

    if attrfield == '00' then
        fault = AArch32.DomainFault(domain, level, acctype, iswrite);
    else
        fault = AArch32.NoFault();

    permissioncheck = (attrfield == '01');

    return (permissioncheck, fault);
```

Library pseudocode for aarch32/translation/checks/AArch32.CheckPermission

```
// AArch32.CheckPermission()
// =========================
// Function used for permission checking from AArch32 stage 1 translations

FaultRecord AArch32.CheckPermission(Permissions perms, bits(32) vaddress, integer level,
                                    bits(4) domain, bit NS, AccType acctype, boolean iswrite)
    assert ELUsingAArch32(S1TranslationRegime());

    if PSTATE.EL != EL2 then
        wxn = SCTLR.WXN == '1';
        if TTBCR.EAE == '1' || SCTLR.AFE == '1' || perms.ap<0> == '1' then
            priv_r = TRUE;
            priv_w = perms.ap<2> == '0';
            user_r = perms.ap<1> == '1';
            user_w = perms.ap<2:1> == '01';
        else
            priv_r = perms.ap<2:1> != '00';
            priv_w = perms.ap<2:1> == '01';
            user_r = perms.ap<1> == '1';
            user_w = FALSE;
        uwxn = SCTLR.UWXN == '1';

        ispriv = AArch32.AccessIsPrivileged(acctype);

        pan = if HavePANExt() then PSTATE.PAN else '0';
        is_ldst   = !(acctype IN {AccType_DC, AccType_DC_UNPRIV, AccType_AT, AccType_IFETCH});
        is_ats1xp = (acctype == AccType_AT && AArch32.ExecutingATS1xPInstr());
        if pan == '1' && user_r && ispriv && (is_ldst || is_ats1xp) then
            priv_r = FALSE;
            priv_w = FALSE;

        user_xn = !user_r || perms.xn == '1' || (user_w && wxn);
        priv_xn = (!priv_r || perms.xn == '1' || perms.pxn == '1' ||
                   (priv_w && wxn) || (user_w && uwxn));

        if ispriv then
            (r, w, xn) = (priv_r, priv_w, priv_xn);
        else
            (r, w, xn) = (user_r, user_w, user_xn);
    else
        // Access from EL2
        wxn = HSCTLR.WXN == '1';
        r = TRUE;
        w = perms.ap<2> == '0';
        xn = perms.xn == '1' || (w && wxn);

    // Restriction on Secure instruction fetch
    if HaveEL(EL3) && IsSecure() && NS == '1' then
        secure_instr_fetch = if ELUsingAArch32(EL3) then SCR.SIF else SCR_EL3.SIF;
        if secure_instr_fetch == '1' then xn = TRUE;

    if acctype == AccType_IFETCH then
        fail = xn;
        failedread = TRUE;
    elsif acctype IN { AccType_ATOMICRW, AccType_ORDEREDRW, AccType_ORDEREDATOMICRW } then
        fail = !r || !w;
        failedread = !r;
    elsif acctype == AccType_DC then
        // DC maintenance instructions operating by VA, cannot fault from stage 1 translation.
        fail = FALSE;
    elsif iswrite then
        fail = !w;
        failedread = FALSE;
    else
        fail = !r;
        failedread = TRUE;

    if fail then
        secondstage = FALSE;
        s2fs1walk = FALSE;
```

```
        ipaddress = bits(40) UNKNOWN;
        return AArch32.PermissionFault(ipaddress,  domain, level, acctype,
                                       !failedread, secondstage, s2fs1walk);
    else
        return AArch32.NoFault();
```

Library pseudocode for aarch32/translation/checks/AArch32.CheckS2Permission

```
// AArch32.CheckS2Permission()
// ===========================
// Function used for permission checking from AArch32 stage 2 translations

FaultRecord AArch32.CheckS2Permission(Permissions perms, bits(32) vaddress, bits(40) ipaddress,
                                      integer level, AccType acctype, boolean iswrite,
                                      boolean s2fs1walk)

    assert HaveEL(EL2) && !IsSecure() && ELUsingAArch32(EL2) && HasS2Translation();

    r = perms.ap<1> == '1';
    w = perms.ap<2> == '1';
    if HaveExtendedExecuteNeverExt() then
        case perms.xn:perms.xxn of
            when '00'  xn = !r;
            when '01'  xn = !r || PSTATE.EL == EL1;
            when '10'  xn = TRUE;
            when '11'  xn = !r || PSTATE.EL == EL0;
    else
        xn = !r || perms.xn == '1';
    // Stage 1 walk is checked as a read, regardless of the original type
    if acctype == AccType_IFETCH && !s2fs1walk then
        fail = xn;
        failedread = TRUE;
    elsif (acctype IN { AccType_ATOMICRW, AccType_ORDEREDRW, AccType_ORDEREDATOMICRW }) && !s2fs1walk the
        fail = !r || !w;
        failedread = !r;
    elsif acctype == AccType_DC && !s2fs1walk then
        // DC maintenance instructions operating by VA, do not generate Permission faults
        // from stage 2 translation, other than from stage 1 translation table walk.
        fail = FALSE;
    elsif iswrite && !s2fs1walk then
        fail = !w;
        failedread = FALSE;
    else
        fail = !r;
        failedread = !iswrite;

    if fail then
        domain = bits(4) UNKNOWN;
        secondstage = TRUE;
        return AArch32.PermissionFault(ipaddress,  domain, level, acctype,
                                       !failedread, secondstage, s2fs1walk);
    else
        return AArch32.NoFault();
```

Library pseudocode for aarch32/translation/debug/AArch32.CheckBreakpoint

```
// AArch32.CheckBreakpoint()
// =========================
// Called before executing the instruction of length "size" bytes at "vaddress" in an AArch32
// translation regime.
// The breakpoint can in fact be evaluated well ahead of execution, for example, at instruction
// fetch. This is the simple sequential execution of the program.

FaultRecord AArch32.CheckBreakpoint(bits(32) vaddress,  integer size)
    assert ELUsingAArch32(S1TranslationRegime());
    assert size IN {2,4};

    match = FALSE;
    mismatch = FALSE;

    for i = 0 to UInt(DBGDIDR.BRPs)
        (match_i, mismatch_i) = AArch32.BreakpointMatch(i, vaddress, size);
        match = match || match_i;
        mismatch = mismatch || mismatch_i;

    if match && HaltOnBreakpointOrWatchpoint() then
        reason = DebugHalt_Breakpoint;
        Halt(reason);
    elsif (match || mismatch) && DBGDSCRext.MDBGen == '1' && AArch32.GenerateDebugExceptions() then
        acctype = AccType_IFETCH;
        iswrite = FALSE;
        debugmoe = DebugException_Breakpoint;
        return AArch32.DebugFault(acctype, iswrite, debugmoe);
    else
        return AArch32.NoFault();
```

Library pseudocode for aarch32/translation/debug/AArch32.CheckDebug

```
// AArch32.CheckDebug()
// ====================
// Called on each access to check for a debug exception or entry to Debug state.

FaultRecord AArch32.CheckDebug(bits(32) vaddress, AccType acctype, boolean iswrite, integer size)

    FaultRecord fault = AArch32.NoFault();

    d_side = (acctype != AccType_IFETCH);
    generate_exception = AArch32.GenerateDebugExceptions() && DBGDSCRext.MDBGen == '1';
    halt = HaltOnBreakpointOrWatchpoint();
    // Relative priority of Vector Catch and Breakpoint exceptions not defined in the architecture
    vector_catch_first = ConstrainUnpredictableBool(Unpredictable_BPVECTORCATCHPRI);

    if !d_side && vector_catch_first && generate_exception then
        fault = AArch32.CheckVectorCatch(vaddress, size);

    if fault.statuscode == Fault_None && (generate_exception || halt) then
        if d_side then
            fault = AArch32.CheckWatchpoint(vaddress, acctype, iswrite, size);
        else
            fault = AArch32.CheckBreakpoint(vaddress, size);

    if fault.statuscode == Fault_None && !d_side && !vector_catch_first && generate_exception then
        return AArch32.CheckVectorCatch(vaddress, size);

    return fault;
```

Library pseudocode for aarch32/translation/debug/AArch32.CheckVectorCatch

```
// AArch32.CheckVectorCatch()
// ==========================
// Called before executing the instruction of length "size" bytes at "vaddress" in an AArch32
// translation regime.
// Vector Catch can in fact be evaluated well ahead of execution, for example, at instruction
// fetch. This is the simple sequential execution of the program.

FaultRecord AArch32.CheckVectorCatch(bits(32) vaddress, integer size)
    assert ELUsingAArch32(S1TranslationRegime());

    match = AArch32.VCRMatch(vaddress);
    if size == 4 && !match && AArch32.VCRMatch(vaddress + 2) then
        match = ConstrainUnpredictableBool(Unpredictable_VCMATCHHALF);

    if match && DBGDSCRext.MDBGen == '1' && AArch32.GenerateDebugExceptions() then
        acctype = AccType_IFETCH;
        iswrite = FALSE;
        debugmoe = DebugException_VectorCatch;
        return AArch32.DebugFault(acctype, iswrite, debugmoe);
    else
        return AArch32.NoFault();
```

Library pseudocode for aarch32/translation/debug/AArch32.CheckWatchpoint

```
// AArch32.CheckWatchpoint()
// =========================
// Called before accessing the memory location of "size" bytes at "address".

FaultRecord AArch32.CheckWatchpoint(bits(32) vaddress, AccType acctype,
                                    boolean iswrite, integer size)
    assert ELUsingAArch32(S1TranslationRegime());

    match = FALSE;
    ispriv = AArch32.AccessIsPrivileged(acctype);

    for i = 0 to UInt(DBGDIDR.WRPs)
        match = match || AArch32.WatchpointMatch(i, vaddress, size, ispriv, iswrite);

    if match && HaltOnBreakpointOrWatchpoint() then
        reason = DebugHalt_Watchpoint;
        Halt(reason);
    elsif match && DBGDSCRext.MDBGen == '1' && AArch32.GenerateDebugExceptions() then
        debugmoe = DebugException_Watchpoint;
        return AArch32.DebugFault(acctype, iswrite, debugmoe);
    else
        return AArch32.NoFault();
```

Library pseudocode for aarch32/translation/faults/AArch32.AccessFlagFault

```
// AArch32.AccessFlagFault()
// =========================

FaultRecord AArch32.AccessFlagFault(bits(40) ipaddress, bits(4) domain, integer level,
                                    AccType acctype, boolean iswrite, boolean secondstage,
                                    boolean s2fs1walk)

    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch32.CreateFaultRecord(Fault_AccessFlag, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.AddressSizeFault

```
// AArch32.AddressSizeFault()
// ==========================

FaultRecord AArch32.AddressSizeFault(bits(40) ipaddress, bits(4) domain, integer level,
                                     AccType acctype, boolean iswrite, boolean secondstage,
                                     boolean s2fs1walk)

    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch32.CreateFaultRecord(Fault_AddressSize, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.AlignmentFault

```
// AArch32.AlignmentFault()
// ========================

FaultRecord AArch32.AlignmentFault(AccType acctype, boolean iswrite, boolean secondstage)

    ipaddress = bits(40) UNKNOWN;
    domain = bits(4) UNKNOWN;
    level = integer UNKNOWN;
    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    s2fs1walk = boolean UNKNOWN;

    return AArch32.CreateFaultRecord(Fault_Alignment, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.AsynchExternalAbort

```
// AArch32.AsynchExternalAbort()
// =============================
// Wrapper function for asynchronous external aborts

FaultRecord AArch32.AsynchExternalAbort(boolean parity, bits(2) errortype, bit extflag)

    faulttype = if parity then Fault_AsyncParity else Fault_AsyncExternal;
    ipaddress = bits(40) UNKNOWN;
    domain = bits(4) UNKNOWN;
    level = integer UNKNOWN;
    acctype = AccType_NORMAL;
    iswrite = boolean UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch32.CreateFaultRecord(faulttype, ipaddress,  domain, level, acctype, iswrite, extflag,
                                     debugmoe,  errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.DebugFault

```
// AArch32.DebugFault()
// ====================

FaultRecord AArch32.DebugFault(AccType acctype, boolean iswrite, bits(4) debugmoe)

    ipaddress = bits(40) UNKNOWN;
    domain = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    level = integer UNKNOWN;
    extflag = bit UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch32.CreateFaultRecord(Fault_Debug, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.DomainFault

```
// AArch32.DomainFault()
// =====================

FaultRecord AArch32.DomainFault(bits(4) domain, integer level, AccType acctype, boolean iswrite)

    ipaddress = bits(40) UNKNOWN;
    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch32.CreateFaultRecord(Fault_Domain, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.NoFault

```
// AArch32.NoFault()
// =================

FaultRecord AArch32.NoFault()

    ipaddress = bits(40) UNKNOWN;
    domain = bits(4) UNKNOWN;
    level = integer UNKNOWN;
    acctype = AccType_NORMAL;
    iswrite = boolean UNKNOWN;
    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch32.CreateFaultRecord(Fault_None, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.PermissionFault

```
// AArch32.PermissionFault()
// =========================

FaultRecord AArch32.PermissionFault(bits(40) ipaddress, bits(4) domain, integer level,
                                    AccType acctype, boolean iswrite, boolean secondstage,
                                    boolean s2fs1walk)

    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch32.CreateFaultRecord(Fault_Permission, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/faults/AArch32.TranslationFault

```
// AArch32.TranslationFault()
// ==========================

FaultRecord AArch32.TranslationFault(bits(40) ipaddress,  bits(4) domain, integer level,
                                     AccType acctype, boolean iswrite, boolean secondstage,
                                     boolean s2fs1walk)

    extflag = bit UNKNOWN;
    debugmoe = bits(4) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch32.CreateFaultRecord(Fault_Translation, ipaddress,  domain, level, acctype, iswrite,
                                     extflag, debugmoe, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch32/translation/translation/AArch32.FirstStageTranslate

```
// AArch32.FirstStageTranslate()
// =============================
// Perform a stage 1 translation walk. The function used by Address Translation operations is
// similar except it uses the translation regime specified for the instruction.

AddressDescriptor AArch32.FirstStageTranslate(bits(32) vaddress, AccType acctype, boolean iswrite,
                                              boolean wasaligned, integer size)

    if PSTATE.EL == EL2 then
        s1_enabled = HSCTLR.M == '1';
    elsif EL2Enabled() then
        tge = (if ELUsingAArch32(EL2) then HCR.TGE else HCR_EL2.TGE);
        dc = (if ELUsingAArch32(EL2) then HCR.DC else HCR_EL2.DC);
        s1_enabled = tge == '0' && dc == '0' && SCTLR.M == '1';
    else
        s1_enabled = SCTLR.M == '1';

    ipaddress = bits(40) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    if s1_enabled then                          // First stage enabled
        use_long_descriptor_format = PSTATE.EL == EL2 || TTBCR.EAE == '1';
        if use_long_descriptor_format then
            S1 = AArch32.TranslationTableWalkLD(ipaddress, vaddress, acctype, iswrite, secondstage,
                                                s2fs1walk, size);
            permissioncheck = TRUE;  domaincheck = FALSE;
        else
            S1 = AArch32.TranslationTableWalkSD(vaddress, acctype, iswrite, size);
            permissioncheck = TRUE;  domaincheck = TRUE;
    else
        S1 = AArch32.TranslateAddressS1Off(vaddress, acctype, iswrite);
        permissioncheck = FALSE;  domaincheck = FALSE;

    if UsingAArch32() && HaveTrapLoadStoreMultipleDeviceExt() && AArch32.ExecutingLSMInstr() then
        if S1.addrdesc.memattrs.memtype == MemType_Device && S1.addrdesc.memattrs.device != DeviceType_GR
            nTLSMD = if S1TranslationRegime() == EL2 then HSCTLR.nTLSMD else SCTLR.nTLSMD;
            if nTLSMD == '0' then
                S1.addrdesc.fault = AArch32.AlignmentFault(acctype, iswrite, secondstage);

    // Check for unaligned data accesses to Device memory
    if ((!wasaligned && acctype != AccType_IFETCH) || (acctype == AccType_DCZVA))
        && S1.addrdesc.memattrs.memtype == MemType_Device && !IsFault(S1.addrdesc) then
        S1.addrdesc.fault = AArch32.AlignmentFault(acctype, iswrite, secondstage);
    if !IsFault(S1.addrdesc) && domaincheck then
        (permissioncheck, abort) = AArch32.CheckDomain(S1.domain, vaddress, S1.level, acctype,
                                                       iswrite);
        S1.addrdesc.fault = abort;

    if !IsFault(S1.addrdesc) && permissioncheck then
        S1.addrdesc.fault = AArch32.CheckPermission(S1.perms, vaddress, S1.level,
                                                    S1.domain, S1.addrdesc.paddress.NS,
                                                    acctype, iswrite);

    // Check for instruction fetches from Device memory not marked as execute-never. If there has
    // not been a Permission Fault then the memory is not marked execute-never.
    if (!IsFault(S1.addrdesc) && S1.addrdesc.memattrs.memtype == MemType_Device &&
        acctype == AccType_IFETCH) then
        S1.addrdesc = AArch32.InstructionDevice(S1.addrdesc, vaddress, ipaddress, S1.level,
                                                S1.domain, acctype, iswrite,
                                                secondstage, s2fs1walk);

    return S1.addrdesc;
```

Library pseudocode for aarch32/translation/translation/AArch32.FullTranslate

```
// AArch32.FullTranslate()
// =======================
// Perform both stage 1 and stage 2 translation walks for the current translation regime. The
// function used by Address Translation operations is similar except it uses the translation
// regime specified for the instruction.

AddressDescriptor AArch32.FullTranslate(bits(32) vaddress, AccType acctype, boolean iswrite,
                                        boolean wasaligned, integer size)

    // First Stage Translation
    S1 = AArch32.FirstStageTranslate(vaddress, acctype, iswrite, wasaligned, size);
    if !IsFault(S1) && !(HaveNV2Ext() && acctype == AccType_NV2REGISTER) && HasS2Translation() then
        s2fs1walk = FALSE;
        result = AArch32.SecondStageTranslate(S1, vaddress, acctype, iswrite, wasaligned, s2fs1walk,
                                              size);
    else
        result = S1;

    return result;
```

Library pseudocode for aarch32/translation/translation/AArch32.SecondStageTranslate

```
// AArch32.SecondStageTranslate()
// ==============================
// Perform a stage 2 translation walk. The function used by Address Translation operations is
// similar except it uses the translation regime specified for the instruction.

AddressDescriptor AArch32.SecondStageTranslate(AddressDescriptor S1, bits(32) vaddress,
                                               AccType acctype, boolean iswrite, boolean wasaligned,
                                               boolean s2fs1walk, integer size)
    assert HasS2Translation();
    assert IsZero(S1.paddress.address<47:40>);
    hwupdatewalk = FALSE;
    if !ELUsingAArch32(EL2) then
        return AArch64.SecondStageTranslate(S1, ZeroExtend(vaddress, 64), acctype, iswrite,
                                            wasaligned, s2fs1walk, size, hwupdatewalk);

    s2_enabled = HCR.VM == '1' || HCR.DC == '1';
    secondstage = TRUE;

    if s2_enabled then                          // Second stage enabled
        ipaddress = S1.paddress.address<39:0>;
        S2 = AArch32.TranslationTableWalkLD(ipaddress, vaddress, acctype, iswrite, secondstage,
                                            s2fs1walk, size);

        // Check for unaligned data accesses to Device memory
        if ((!wasaligned && acctype != AccType_IFETCH) || (acctype == AccType_DCZVA))
            && S2.addrdesc.memattrs.memtype == MemType_Device && !IsFault(S2.addrdesc) then
            S2.addrdesc.fault = AArch32.AlignmentFault(acctype, iswrite, secondstage);

        // Check for permissions on Stage2 translations
        if !IsFault(S2.addrdesc) then
            S2.addrdesc.fault = AArch32.CheckS2Permission(S2.perms, vaddress, ipaddress, S2.level,
                                                          acctype, iswrite, s2fs1walk);

        // Check for instruction fetches from Device memory not marked as execute-never. As there
        // has not been a Permission Fault then the memory is not marked execute-never.
        if (!s2fs1walk && !IsFault(S2.addrdesc) && S2.addrdesc.memattrs.memtype == MemType_Device &&
            acctype == AccType_IFETCH) then
            domain = bits(4) UNKNOWN;
            S2.addrdesc = AArch32.InstructionDevice(S2.addrdesc, vaddress, ipaddress, S2.level,
                                                    domain, acctype, iswrite,
                                                    secondstage, s2fs1walk);

        // Check for protected table walk
        if (s2fs1walk && !IsFault(S2.addrdesc) && HCR.PTW == '1' &&
            S2.addrdesc.memattrs.memtype == MemType_Device) then
            domain = bits(4) UNKNOWN;
            S2.addrdesc.fault = AArch32.PermissionFault(ipaddress,   domain, S2.level, acctype,
                                                        iswrite, secondstage, s2fs1walk);

        result = CombineS1S2Desc(S1, S2.addrdesc);
    else
        result = S1;

    return result;
```

Library pseudocode for aarch32/translation/translation/AArch32.SecondStageWalk

```
// AArch32.SecondStageWalk()
// =========================
// Perform a stage 2 translation on a stage 1 translation page table walk access.

AddressDescriptor AArch32.SecondStageWalk(AddressDescriptor S1, bits(32) vaddress, AccType acctype,
                                          boolean iswrite, integer size)

    assert HasS2Translation();

    s2fs1walk = TRUE;
    wasaligned = TRUE;
    return AArch32.SecondStageTranslate(S1, vaddress, acctype, iswrite, wasaligned, s2fs1walk,
                                        size);
```

Library pseudocode for aarch32/translation/translation/AArch32.TranslateAddress

```
// AArch32.TranslateAddress()
// ==========================
// Main entry point for translating an address

AddressDescriptor AArch32.TranslateAddress(bits(32) vaddress, AccType acctype, boolean iswrite,
                                           boolean wasaligned, integer size)

    if !ELUsingAArch32(S1TranslationRegime()) then
        return AArch64.TranslateAddress(ZeroExtend(vaddress, 64), acctype, iswrite, wasaligned,
                                        size);
    result = AArch32.FullTranslate(vaddress, acctype, iswrite, wasaligned, size);

    if !(acctype IN {AccType_PTW, AccType_IC, AccType_AT}) && !IsFault(result) then
        result.fault = AArch32.CheckDebug(vaddress, acctype, iswrite, size);

    // Update virtual address for abort functions
    result.vaddress = ZeroExtend(vaddress);

    return result;
```

Library pseudocode for aarch32/translation/walk/AArch32.TranslationTableWalkLD

```
// AArch32.TranslationTableWalkLD()
// ================================
// Returns a result of a translation table walk using the Long-descriptor format
//
// Implementations might cache information from memory in any number of non-coherent TLB
// caching structures, and so avoid memory accesses that have been expressed in this
// pseudocode. The use of such TLBs is not expressed in this pseudocode.

TLBRecord AArch32.TranslationTableWalkLD(bits(40) ipaddress, bits(32) vaddress,
                                         AccType acctype, boolean iswrite, boolean secondstage,
                                         boolean s2fs1walk, integer size)
    if !secondstage then
        assert ELUsingAArch32(S1TranslationRegime());
    else
        assert HaveEL(EL2) && !IsSecure() && ELUsingAArch32(EL2) && HasS2Translation();

    TLBRecord result;
    AddressDescriptor descaddr;
    bits(64) baseregister;
    bits(40) inputaddr;         // Input Address is 'vaddress' for stage 1, 'ipaddress' for stage 2
    bit nswalk;                     // Stage 2 translation table walks are to Secure or to Non-secure PA s

    domain = bits(4) UNKNOWN;

    descaddr.memattrs.memtype = MemType_Normal;

    // Fixed parameters for the page table walk:
    //  grainsize = Log2(Size of Table)         - Size of Table is 4KB in AArch32
    //  stride = Log2(Address per Level)        - Bits of address consumed at each level
    constant integer grainsize = 12;                    // Log2(4KB page size)
    constant integer stride = grainsize - 3;            // Log2(page size / 8 bytes)

    // Derived parameters for the page table walk:
    //  inputsize = Log2(Size of Input Address) - Input Address size in bits
    //  level = Level to start walk from
    // This means that the number of levels after start level = 3-level

    if !secondstage then
        // First stage translation
        inputaddr = ZeroExtend(vaddress);
        el = AArch32.AccessUsesEL(acctype);
        if el == EL2 then
            inputsize = 32 - UInt(HTCR.T0SZ);
            basefound = inputsize == 32 || IsZero(inputaddr<31:inputsize>);
            disabled = FALSE;
            baseregister = HTTBR;
            descaddr.memattrs = WalkAttrDecode(HTCR.SH0, HTCR.ORGN0, HTCR.IRGN0, secondstage);
            reversedescriptors = HSCTLR.EE == '1';
            lookupsecure = FALSE;
            singlepriv = TRUE;
            hierattrsdisabled = AArch32.HaveHPDExt() && HTCR.HPD == '1';
        else
            basefound = FALSE;
            disabled = FALSE;
            t0size = UInt(TTBCR.T0SZ);
            if t0size == 0 || IsZero(inputaddr<31:(32-t0size)>) then
                inputsize = 32 - t0size;
                basefound = TRUE;
                baseregister = TTBR0;
                descaddr.memattrs = WalkAttrDecode(TTBCR.SH0, TTBCR.ORGN0, TTBCR.IRGN0, secondstage);
                hierattrsdisabled = AArch32.HaveHPDExt() && TTBCR.T2E == '1' &&  TTBCR2.HPD0 == '1';
            t1size = UInt(TTBCR.T1SZ);
            if (t1size == 0 && !basefound) || (t1size > 0 && IsOnes(inputaddr<31:(32-t1size)>)) then
                inputsize = 32 - t1size;
                basefound = TRUE;
                baseregister = TTBR1;
                descaddr.memattrs = WalkAttrDecode(TTBCR.SH1, TTBCR.ORGN1, TTBCR.IRGN1, secondstage);
                hierattrsdisabled = AArch32.HaveHPDExt() && TTBCR.T2E == '1' &&  TTBCR2.HPD1 == '1';
            reversedescriptors = SCTLR.EE == '1';
            lookupsecure = IsSecure();
```

```
            singlepriv = FALSE;
        // The starting level is the number of strides needed to consume the input address
        level = 4 - (1 + (inputsize - grainsize - 1) DIV stride);

    else
        // Second stage translation
        inputaddr = ipaddress;
        inputsize = 32 - level = 4 - RoundUp(Real(inputsize - grainsize) / Real(stride));

    else
        // Second stage translation
        inputaddr = ipaddress;
        inputsize = 32 - SInt(VTCR.T0SZ);
        // VTCR.S must match VTCR.T0SZ[3]
        if VTCR.S != VTCR.T0SZ<3> then
            (-, inputsize) = ConstrainUnpredictableInteger(32-7, 32+8, Unpredictable_RESVTCRS);
        basefound = inputsize == 40 || IsZero(inputaddr<39:inputsize>);
        disabled = FALSE;
        descaddr.memattrs = WalkAttrDecode(VTCR.SH0, VTCR.ORGN0, VTCR.IRGN0, secondstage);
        reversedescriptors = HSCTLR.EE == '1';
        singlepriv = TRUE;

        lookupsecure = FALSE;
        baseregister = VTTBR;
        startlevel = UInt(VTCR.SL0);
        level = 2 - startlevel;
        if level <= 0 then basefound = FALSE;

        // Number of entries in the starting level table =
        //     (Size of Input Address)/((Address per level)^(Num levels remaining)*(Size of Table))
        startsizecheck = inputsize - ((3 - level)*stride + grainsize); // Log2(Num of entries)

        // Check for starting level table with fewer than 2 entries or longer than 16 pages.
        // Lower bound check is:  startsizecheck < Log2(2 entries)
        //   That is, VTCR.SL0 == '00' and SInt(VTCR.T0SZ) > 1, Size of Input Address < 2^31 bytes
        // Upper bound check is:  startsizecheck > Log2(pagesize/8*16)
        //   That is, VTCR.SL0 == '01' and SInt(VTCR.T0SZ) < -2, Size of Input Address > 2^34 bytes
        if startsizecheck < 1 || startsizecheck > stride + 4 then basefound = FALSE;

    if !basefound || disabled then
        level = 1;           // AArch64 reports this as a level 0 fault
        result.addrdesc.fault = AArch32.TranslationFault(ipaddress,   domain, level, acctype, iswrite,
                                                         secondstage, s2fs1walk);
        return result;

    if !IsZero(baseregister<47:40>) then
        level = 0;
        result.addrdesc.fault = AArch32.AddressSizeFault(ipaddress,  domain, level, acctype, iswrite,
                                                         secondstage, s2fs1walk);
        return result;

    // Bottom bound of the Base address is:
    //     Log2(8 bytes per entry)+Log2(Number of entries in starting level table)
    // Number of entries in starting level table =
    //     (Size of Input Address)/((Address per level)^(Num levels remaining)*(Size of Table))
    baselowerbound = 3 + inputsize - ((3-level)*stride + grainsize);  // Log2(Num of entries*8)
    baseaddress = baseregister<39:baselowerbound>:Zeros(baselowerbound);

    ns_table = if lookupsecure then '0' else '1';
    ap_table = '00';
    xn_table = '0';
    pxn_table = '0';

    addrselecttop = inputsize - 1;

    repeat
        addrselectbottom = (3-level)*stride + grainsize;

        bits(40) index = ZeroExtend(inputaddr<addrselecttop:addrselectbottom>:'000');
        descaddr.paddress.address = ZeroExtend(baseaddress OR index);
```

```
        descaddr.paddress.NS = ns_table;
        descaddr.paddress.NS = if secondstage then nswalk else ns_table;

        // If there are two stages of translation, then the first stage table walk addresses
        // are themselves subject to translation
        if secondstage || !HasS2Translation() || (HaveNV2Ext() && acctype == AccType_NV2REGISTER) then
            descaddr2 = descaddr;
        else
            descaddr2 = AArch32.SecondStageWalk(descaddr, vaddress, acctype, iswrite, 8);
            // Check for a fault on the stage 2 walk
            if IsFault(descaddr2) then
                result.addrdesc.fault = descaddr2.fault;
                return result;

        // Update virtual address for abort functions
        descaddr2.vaddress = ZeroExtend(vaddress);

        accdesc = CreateAccessDescriptorPTW(acctype, secondstage, s2fs1walk, level);
(vaddress);

        accdesc = CreateAccessDescriptorPTW(acctype, secondstage, s2fs1walk, level);
        desc = _Mem[descaddr2, 8, accdesc];

        if reversedescriptors then desc = BigEndianReverse(desc);

        if desc<0> == '0' || (desc<1:0> == '01' && level == 3) then
             // Fault (00), Reserved (10), or Block (01) at level 3.
            result.addrdesc.fault = AArch32.TranslationFault(ipaddress,  domain, level, acctype,
                                                             iswrite, secondstage, s2fs1walk);
            return result;

        // Valid Block, Page, or Table entry
        if desc<1:0> == '01' || level == 3 then                 // Block (01) or Page (11)
            blocktranslate = TRUE;
        else                                                    // Table (11)
            if !IsZero(desc<47:40>) then
                result.addrdesc.fault = AArch32.AddressSizeFault(ipaddress,  domain, level, acctype,
                                                                 iswrite, secondstage, s2fs1walk);
                return result;

            baseaddress = desc<39:grainsize>:Zeros(grainsize);
            if !secondstage then
                // Unpack the upper and lower table attributes
                ns_table    = ns_table    OR desc<63>;
            if !secondstage && !hierattrsdisabled then
                ap_table<1> = ap_table<1> OR desc<62>;       // read-only

                xn_table    = xn_table    OR desc<60>;
                // pxn_table and ap_table[0] apply only in EL1&0 translation regimes
                if !singlepriv then
                    pxn_table   = pxn_table   OR desc<59>;
                    ap_table<0> = ap_table<0> OR desc<61>;   // privileged

            level = level + 1;
            addrselecttop = addrselectbottom - 1;
            blocktranslate = FALSE;
    until blocktranslate;

    // Unpack the descriptor into address and upper and lower block attributes
    outputaddress = desc<39:addrselectbottom>:inputaddr<addrselectbottom-1:0>;

    // Check the output address is inside the supported range
    if !IsZero(desc<47:40>) then
        result.addrdesc.fault = AArch32.AddressSizeFault(ipaddress,  domain, level, acctype,
                                                         iswrite, secondstage, s2fs1walk);
        return result;

    // Check the access flag
    if desc<10> == '0' then
        result.addrdesc.fault = AArch32.AccessFlagFault(ipaddress,  domain, level, acctype,
```

```
                                                    iswrite, secondstage, s2fs1walk);
    return result;
xn = desc<54>;                                          // Bit[54] of the block/page descriptor hol
pxn = desc<53>;                                         // Bit[53] of the block/page descriptor hol
ap = desc<7:6>:'1';                                     // Bits[7:6] of the block/page descriptor h
contiguousbit = desc<52>;
nG = desc<11>;
sh = desc<9:8>;
mattr = desc<5:2>;                                      // AttrIndx and NS bit in stage 1

result.domain = bits(4) UNKNOWN;                        // Domains not used
result.level = level;
result.blocksize = 2^((3-level)*stride + grainsize);

// Stage 1 translation regimes also inherit attributes from the tables
if !secondstage then
    result.perms.xn      = xn OR xn_table;
    result.perms.ap<2>   = ap<2> OR ap_table<1>;        // Force read-only
    // PXN, nG and AP[1] apply only in EL1&0 stage 1 translation regimes
    if !singlepriv then
        result.perms.ap<1> = ap<1> AND NOT(ap_table<0>);  // Force privileged only
        result.perms.pxn   = pxn OR pxn_table;
        // Pages from Non-secure tables are marked non-global in Secure EL1&0
        if IsSecure() then
            result.nG = nG OR ns_table;
        else
            result.nG = nG;
    else
        result.perms.ap<1> = '1';
        result.perms.pxn   = '0';
        result.nG          = '0';
    result.GP = desc<50>;                               // Stage 1 block or pages might be guarded
    result.perms.ap<0>   = '1';
    result.addrdesc.memattrs = AArch32.S1AttrDecode(sh, mattr<2:0>, acctype);
    result.addrdesc.paddress.NS = mattr<3> OR ns_table;
else
    result.perms.ap<2:1> = ap<2:1>;
    result.perms.ap<0>   = '1';
    result.perms.xn      = xn;
    if HaveExtendedExecuteNeverExt() then result.perms.xxn = desc<53>;
    result.perms.pxn     = '0';
    result.nG            = '0';
    if s2fs1walk then
        result.addrdesc.memattrs = S2AttrDecode(sh, mattr, AccType_PTW);
    else
        result.addrdesc.memattrs = S2AttrDecode(sh, mattr, acctype);
    result.addrdesc.paddress.NS = '1';

result.addrdesc.paddress.address = ZeroExtend(outputaddress);
result.addrdesc.fault = AArch32.NoFault();
result.contiguous = contiguousbit == '1';
if HaveCommonNotPrivateTransExt() then result.CnP = baseregister<0>;

return result;
```

Library pseudocode for aarch32/translation/walk/AArch32.TranslationTableWalkSD

```
// AArch32.TranslationTableWalkSD()
// ================================
// Returns a result of a translation table walk using the Short-descriptor format
//
// Implementations might cache information from memory in any number of non-coherent TLB
// caching structures, and so avoid memory accesses that have been expressed in this
// pseudocode. The use of such TLBs is not expressed in this pseudocode.

TLBRecord AArch32.TranslationTableWalkSD(bits(32) vaddress, AccType acctype, boolean iswrite,
                                         integer size)
    assert ELUsingAArch32(S1TranslationRegime());

    // This is only called when address translation is enabled
    TLBRecord         result;
    AddressDescriptor l1descaddr;
    AddressDescriptor l2descaddr;
    bits(40)      outputaddress;

    // Variables for Abort functions
    ipaddress = bits(40) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;
    NS = bit UNKNOWN;

    // Default setting of the domain
    domain = bits(4) UNKNOWN;

    // Determine correct Translation Table Base Register to use.
    bits(64) ttbr;
    n = UInt(TTBCR.N);
    if n == 0 || IsZero(vaddress<31:(32-n)>) then
        ttbr = TTBR0;
        disabled = (TTBCR.PD0 == '1');
    else
        ttbr = TTBR1;
        disabled = (TTBCR.PD1 == '1');
        n = 0;  // TTBR1 translation always works like N=0 TTBR0 translation

    // Check this Translation Table Base Register is not disabled.
    if disabled then
        level = 1;
        result.addrdesc.fault = AArch32.TranslationFault(ipaddress, domain, level, acctype, iswrite,
                                                         secondstage, s2fs1walk);
        return result;

    // Obtain descriptor from initial lookup.
    l1descaddr.paddress.address = ZeroExtend(ttbr<31:14-n>:vaddress<31-n:20>:'00');
    l1descaddr.paddress.NS = if IsSecure() then '0' else '1';
    IRGN = ttbr<0>:ttbr<6>;             // TTBR.IRGN
    RGN = ttbr<4:3>;                    // TTBR.RGN
    SH = ttbr<1>:ttbr<5>;               // TTBR.S:TTBR.NOS
    l1descaddr.memattrs = WalkAttrDecode(SH, RGN, IRGN, secondstage);

    if !HaveEL(EL2) || (IsSecure() && !IsSecureEL2Enabled()) then
        // if only 1 stage of translation
        l1descaddr2 = l1descaddr;
    else
        l1descaddr2 = AArch32.SecondStageWalk(l1descaddr, vaddress, acctype, iswrite, 4);
        // Check for a fault on the stage 2 walk
        if IsFault(l1descaddr2) then
            result.addrdesc.fault = l1descaddr2.fault;
            return result;

    // Update virtual address for abort functions
    l1descaddr2.vaddress = ZeroExtend(vaddress);

    accdesc = CreateAccessDescriptorPTW(acctype, secondstage, s2fs1walk, level);
    l1desc = _Mem[l1descaddr2, 4,accdesc];

    if SCTLR.EE == '1' then l1desc = BigEndianReverse(l1desc);
```

```
// Process descriptor from initial lookup.
case l1desc<1:0> of
    when '00'                                                   // Fault, Reserved
        level = 1;
        result.addrdesc.fault = AArch32.TranslationFault(ipaddress, domain, level, acctype,
                                                         iswrite, secondstage, s2fs1walk);
        return result;

    when '01'                                                   // Large page or Small page
        domain = l1desc<8:5>;
        level = 2;
        pxn = l1desc<2>;
        NS = l1desc<3>;

        // Obtain descriptor from level 2 lookup.
        l2descaddr.paddress.address = ZeroExtend(l1desc<31:10>:vaddress<19:12>:'00');
        l2descaddr.paddress.NS = if IsSecure() then '0' else '1';
        l2descaddr.memattrs = l1descaddr.memattrs;

        if !HaveEL(EL2) || (IsSecure() && !IsSecureEL2Enabled()) then
            // if only 1 stage of translation
            l2descaddr2 = l2descaddr;
        else
            l2descaddr2 = AArch32.SecondStageWalk(l2descaddr, vaddress, acctype, iswrite, 4);
            // Check for a fault on the stage 2 walk
            if IsFault(l2descaddr2) then
                result.addrdesc.fault = l2descaddr2.fault;
                return result;

        // Update virtual address for abort functions
        l2descaddr2.vaddress = ZeroExtend(vaddress);

        accdesc = CreateAccessDescriptorPTW(acctype, secondstage, s2fs1walk, level);
        l2desc = _Mem[l2descaddr2, 4, accdesc];

        if SCTLR.EE == '1' then l2desc = BigEndianReverse(l2desc);

        // Process descriptor from level 2 lookup.
        if l2desc<1:0> == '00' then
            result.addrdesc.fault = AArch32.TranslationFault(ipaddress, domain, level, acctype,
                                                             iswrite, secondstage, s2fs1walk);
            return result;

        nG = l2desc<11>;
        S = l2desc<10>;
        ap = l2desc<9,5:4>;

        if SCTLR.AFE == '1' && l2desc<4> == '0' then
            // Armv8 VMSAv8-32 does not support hardware management of the Access flag.
            result.addrdesc.fault = AArch32.AccessFlagFault(ipaddress, domain, level, acctype,
                                                            iswrite, secondstage, s2fs1walk);
            return result;

        if l2desc<1> == '0' then                                // Large page
            xn = l2desc<15>;
            tex = l2desc<14:12>;
            c = l2desc<3>;
            b = l2desc<2>;
            blocksize = 64;
            outputaddress = ZeroExtend(l2desc<31:16>:vaddress<15:0>);
        else                                                    // Small page
            tex = l2desc<8:6>;
            c = l2desc<3>;
            b = l2desc<2>;
            xn = l2desc<0>;
            blocksize = 4;
            outputaddress = ZeroExtend(l2desc<31:12>:vaddress<11:0>);

    when '1x'                                                   // Section or Supersection
```

```
            NS = l1desc<19>;
            nG = l1desc<17>;
            S = l1desc<16>;
            ap = l1desc<15,11:10>;
            tex = l1desc<14:12>;
            xn = l1desc<4>;
            c = l1desc<3>;
            b = l1desc<2>;
            pxn = l1desc<0>;
            level = 1;

            if SCTLR.AFE == '1' && l1desc<10> == '0' then
                // Armv8 VMSAv8-32 does not support hardware management of the Access flag.
                result.addrdesc.fault = AArch32.AccessFlagFault(ipaddress, domain, level, acctype,
                                                                iswrite, secondstage, s2fs1walk);
                return result;

            if l1desc<18> == '0' then                           // Section
                domain = l1desc<8:5>;
                blocksize = 1024;
                outputaddress = ZeroExtend(l1desc<31:20>:vaddress<19:0>);
            else                                                // Supersection
                domain = '0000';
                blocksize = 16384;
                outputaddress = l1desc<8:5>:l1desc<23:20>:l1desc<31:24>:vaddress<23:0>;

    // Decode the TEX, C, B and S bits to produce the TLBRecord's memory attributes
    if SCTLR.TRE == '0' then
        if RemapRegsHaveResetValues() then
            result.addrdesc.memattrs = AArch32.DefaultTEXDecode(tex, c, b, S, acctype);
        else
            result.addrdesc.memattrs = MemoryAttributes IMPLEMENTATION_DEFINED;
    else
        result.addrdesc.memattrs = AArch32.RemappedTEXDecode(tex, c, b, S, acctype);

    // Set the rest of the TLBRecord, try to add it to the TLB, and return it.
    result.perms.ap = ap;
    result.perms.xn = xn;
    result.perms.pxn = pxn;
    result.nG = nG;
    result.domain = domain;
    result.level = level;
    result.blocksize = blocksize;
    result.addrdesc.paddress.address = ZeroExtend(outputaddress);
    result.addrdesc.paddress.NS = if IsSecure() then NS else '1';
    result.addrdesc.fault = AArch32.NoFault();

    return result;
```

Library pseudocode for aarch32/translation/walk/RemapRegsHaveResetValues

```
boolean RemapRegsHaveResetValues();
```

Library pseudocode for aarch64/debug/breakpoint/AArch64.BreakpointMatch

```
// AArch64.BreakpointMatch()
// =========================
// Breakpoint matching in an AArch64 translation regime.

boolean AArch64.BreakpointMatch(integer n, bits(64) vaddress, AccType acctype, integer size)
    assert !ELUsingAArch32(S1TranslationRegime());
    assert n <= UInt(ID_AA64DFR0_EL1.BRPs);

    enabled = DBGBCR_EL1[n].E == '1';
    ispriv = PSTATE.EL != EL0;
    linked = DBGBCR_EL1[n].BT == '0x01';
    isbreakpnt = TRUE;
    linked_to = FALSE;

    state_match = AArch64.StateMatch(DBGBCR_EL1[n].SSC, DBGBCR_EL1[n].HMC, DBGBCR_EL1[n].PMC,
                                     linked, DBGBCR_EL1[n].LBN, isbreakpnt, acctype, ispriv);
    value_match = AArch64.BreakpointValueMatch(n, vaddress, linked_to);

    if HaveAnyAArch32() && size == 4 then                 // Check second halfword
        // If the breakpoint address and BAS of an Address breakpoint match the address of the
        // second halfword of an instruction, but not the address of the first halfword, it is
        // CONSTRAINED UNPREDICTABLE whether or not this breakpoint generates a Breakpoint debug
        // event.
        match_i = AArch64.BreakpointValueMatch(n, vaddress + 2, linked_to);
        if !value_match && match_i then
            value_match = ConstrainUnpredictableBool(Unpredictable_BPMATCHHALF);

    if vaddress<1> == '1' && DBGBCR_EL1[n].BAS == '1111' then
        // The above notwithstanding, if DBGBCR_EL1[n].BAS == '1111', then it is CONSTRAINED
        // UNPREDICTABLE whether or not a Breakpoint debug event is generated for an instruction
        // at the address DBGBVR_EL1[n]+2.
        if value_match then value_match = ConstrainUnpredictableBool(Unpredictable_BPMATCHHALF);

    match = value_match && state_match && enabled;

    return match;
```

Library pseudocode for aarch64/debug/breakpoint/AArch64.BreakpointValueMatch

```
// AArch64.BreakpointValueMatch()
// ==============================

boolean AArch64.BreakpointValueMatch(integer n, bits(64) vaddress, boolean linked_to)

    // "n" is the identity of the breakpoint unit to match against.
    // "vaddress" is the current instruction address, ignored if linked_to is TRUE and for Context
    //   matching breakpoints.
    // "linked_to" is TRUE if this is a call from StateMatch for linking.

    // If a non-existent breakpoint then it is CONSTRAINED UNPREDICTABLE whether this gives
    // no match or the breakpoint is mapped to another UNKNOWN implemented breakpoint.
    if n > UInt(ID_AA64DFR0_EL1.BRPs) then
        (c, n) = ConstrainUnpredictableInteger(0, UInt(ID_AA64DFR0_EL1.BRPs), Unpredictable_BPNOTIMPL);
        assert c IN {Constraint_DISABLED, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then return FALSE;

    // If this breakpoint is not enabled, it cannot generate a match. (This could also happen on a
    // call from StateMatch for linking).
    if DBGBCR_EL1[n].E == '0' then return FALSE;

    context_aware = (n >= UInt(ID_AA64DFR0_EL1.BRPs) - UInt(ID_AA64DFR0_EL1.CTX_CMPs));

    // If BT is set to a reserved type, behaves either as disabled or as a not-reserved type.
    dbgtype = DBGBCR_EL1[n].BT;

    if ((dbgtype IN {'011x','11xx'} && !HaveVirtHostExt()) ||              // Context matching
          dbgtype == '010x' ||                                             // Reserved
          (dbgtype != '0x0x' && !context_aware) ||                         // Context matching
          (dbgtype == '1xxx' && !HaveEL(EL2))) then                        // EL2 extension
        (c, dbgtype) = ConstrainUnpredictableBits(Unpredictable_RESBPTYPE);
        assert c IN {Constraint_DISABLED, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then return FALSE;
        // Otherwise the value returned by ConstrainUnpredictableBits must be a not-reserved value

    // Determine what to compare against.
    match_addr = (dbgtype == '0x0x');
    match_vmid = (dbgtype == '10xx');
    match_cid  = (dbgtype == '001x');
    match_cid1 = (dbgtype IN { '101x', 'x11x'});
    match_cid2 = (dbgtype == '11xx');
    linked     = (dbgtype == 'xxx1');

    // If this is a call from StateMatch, return FALSE if the breakpoint is not programmed for a
    // VMID and/or context ID match, of if not context-aware. The above assertions mean that the
    // code can just test for match_addr == TRUE to confirm all these things.
    if linked_to && (!linked || match_addr) then return FALSE;

    // If called from BreakpointMatch return FALSE for Linked context ID and/or VMID matches.
    if !linked_to && linked && !match_addr then return FALSE;

    // Do the comparison.
    if match_addr then
        byte = UInt(vaddress<1:0>);
        if HaveAnyAArch32() then
            // T32 instructions can be executed at EL0 in an AArch64 translation regime.
            assert byte IN {0,2};                  // "vaddress" is halfword aligned
            byte_select_match = (DBGBCR_EL1[n].BAS<byte> == '1');
        else
            assert byte == 0;                      // "vaddress" is word aligned
            byte_select_match = TRUE;              // DBGBCR_EL1[n].BAS<byte> is RES1
        top = AddrTop(vaddress, TRUE, PSTATE.EL);
        BVR_match = vaddress<top:2> == DBGBVR_EL1[n]<top:2> && byte_select_match;
    elsif match_cid then
        if IsInHost() then
            BVR_match = (CONTEXTIDR_EL2 == DBGBVR_EL1[n]<31:0>);
        else
            BVR_match = (PSTATE.EL IN {EL0, EL1} && CONTEXTIDR_EL1 == DBGBVR_EL1[n]<31:0>);
    elsif match_cid1 then
        BVR_match = (PSTATE.EL IN {EL0, EL1} && !IsInHost() && CONTEXTIDR_EL1 == DBGBVR_EL1[n]<31:0>);
```

```
    if match_vmid then
        if !Have16bitVMID() || VTCR_EL2.VS == '0' then
            vmid = ZeroExtend(VTTBR_EL2.VMID<7:0>, 16);
            bvr_vmid = ZeroExtend(DBGBVR_EL1[n]<39:32>, 16);
        else
            vmid = VTTBR_EL2.VMID;
            bvr_vmid = DBGBVR_EL1[n]<47:32>;
        BXVR_match = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                      !IsInHost() &&
                      vmid == bvr_vmid);
    elsif match_cid2 then
        BXVR_match = (!IsSecure() && HaveVirtHostExt() &&
                      DBGBVR_EL1[n]<63:32> == CONTEXTIDR_EL2);

    bvr_match_valid = (match_addr || match_cid || match_cid1);
    bxvr_match_valid = (match_vmid || match_cid2);

    match = (!bxvr_match_valid || BXVR_match) && (!bvr_match_valid || BVR_match);

    return match;
```

Library pseudocode for aarch64/debug/breakpoint/AArch64.StateMatch

```
// AArch64.StateMatch()
// ====================
// Determine whether a breakpoint or watchpoint is enabled in the current mode and state.

boolean AArch64.StateMatch(bits(2) SSC, bit HMC, bits(2) PxC, boolean linked, bits(4) LBN,
                           boolean isbreakpnt, AccType acctype, boolean ispriv)
    // "SSC", "HMC", "PxC" are the control fields from the DBGBCR[n] or DBGWCR[n] register.
    // "linked" is TRUE if this is a linked breakpoint/watchpoint type.
    // "LBN" is the linked breakpoint number from the DBGBCR[n] or DBGWCR[n] register.
    // "isbreakpnt" is TRUE for breakpoints, FALSE for watchpoints.
    // "ispriv" is valid for watchpoints, and selects between privileged and unprivileged accesses.

    // If parameters are set to a reserved type, behaves as either disabled or a defined type
    (c, SSC, HMC, PxC) =     if ((HMC:SSC:PxC) IN {'011xx','100x0','101x0','11010','11101','1111x'} ||
          (HMC == '0' && PxC == '00' && (!isbreakpnt || ! CheckValidStateMatchHaveAArch32EL(SSC, HMC, PxC
    if c ==( EL1))) ||     // Usr/Svc/Sys
          (SSC IN {'01','10'} && !HaveEL(EL3)) ||                                          // No EL3
          (HMC:SSC != '000' && HMC:SSC != '111' && !HaveEL(EL3) && !HaveEL(EL2)) || // No EL3/EL2
          (HMC:SSC:PxC == '11100' && !HaveEL(EL2))) then                                   // No EL2
        (c, <HMC,SSC,PxC>) = ConstrainUnpredictableBits(Unpredictable_RESBPWPCTRL);
        assert c IN {Constraint_DISABLED then return FALSE;
    // Otherwise the HMC,SSC,PxC values are either valid or the values returned by
    // CheckValidStateMatch are valid.

    EL3_match =, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then return FALSE;
        // Otherwise the value returned by ConstrainUnpredictableBits must be a not-reserved value

    EL3_match = HaveEL(EL3) && HMC == '1' && SSC<0> == '0';
    EL2_match = HaveEL(EL2) && ((HMC == '1' && (SSC:PxC != '1000')) || SSC == '11');
) && HMC == '1';
    EL1_match = PxC<0> == '1';
    EL0_match = PxC<1> == '1';

    if    el = if HaveNV2Ext() && acctype == AccType_NV2REGISTER && !isbreakpnt then
        priv_match = EL2_match;
    elsif !ispriv && !isbreakpnt then
        priv_match = EL0_match;
    else
        case PSTATE.EL of
            whenthen EL2 else PSTATE.EL;
    if !ispriv && !isbreakpnt then
        priv_match = EL0_match;
    else
        case el of
            when EL3  priv_match = EL3_match;
            when EL2  priv_match = EL2_match;
            when EL1  priv_match = EL1_match;
            when EL0  priv_match = EL0_match;

    case SSC of
        when '00'  security_state_match = TRUE;                          // Both
        when '01'  security_state_match = !IsSecure();                   // Non-secure only
        when '10'  security_state_match =priv_match = EL0_match;

    case SSC of
        when '00'  security_state_match = TRUE;          // Both
        when '01'  security_state_match = ! IsSecure();                  // Secure only
        when '11'  security_state_match = (HMC == '1' ||();  // Non-secure only
        when '10'  security_state_match = IsSecure());  // HMC=1 -> Both, 0 -> Secure only
();   // Secure only
        when '11'  security_state_match = TRUE;          // Both

    if linked then
        // "LBN" must be an enabled context-aware breakpoint unit. If it is not context-aware then
        // it is CONSTRAINED UNPREDICTABLE whether this gives no match, or LBN is mapped to some
        // UNKNOWN breakpoint that is context-aware.
        lbn = UInt(LBN);
        first_ctx_cmp = (UInt(ID_AA64DFR0_EL1.BRPs) - UInt(ID_AA64DFR0_EL1.CTX_CMPs));
        last_ctx_cmp = UInt(ID_AA64DFR0_EL1.BRPs);
```

```
        if (lbn < first_ctx_cmp || lbn > last_ctx_cmp) then
            (c, lbn) = ConstrainUnpredictableInteger(first_ctx_cmp, last_ctx_cmp, Unpredictable_BPNOTCTXC
            assert c IN {Constraint_DISABLED, Constraint_NONE, Constraint_UNKNOWN};
            case c of
                when Constraint_DISABLED  return FALSE;      // Disabled
                when Constraint_NONE      linked = FALSE;    // No linking
                // Otherwise ConstrainUnpredictableInteger returned a context-aware breakpoint

    if linked then
        vaddress = bits(64) UNKNOWN;
        linked_to = TRUE;
        linked_match = AArch64.BreakpointValueMatch(lbn, vaddress, linked_to);

    return priv_match && security_state_match && (!linked || linked_match);
```

Library pseudocode for aarch64/debug/breakpoint/CheckValidStateMatch

```
// CheckValidStateMatch()
// ======================
// Checks for an invalid state match that will generate Constrained Unpredictable behaviour, otherwise
// returns Constraint_NONE.

(Constraint, bits(2), bit, bits(2)) CheckValidStateMatch(bits(2) SSC, bit HMC, bits(2) PxC, boolean isbre
    boolean reserved = FALSE;

    // Match 'Usr/Sys/Svc' only valid for AArch32 breakpoints
    if (!isbreakpnt || !HaveAArch32EL(EL1)) && HMC:PxC == '000' && SSC != '11' then
        reserved = TRUE;

    // Both EL3 and EL2 are not implemented
    if !HaveEL(EL3) && !HaveEL(EL2) && (HMC != '0' || SSC != '00') then
        reserved = TRUE;

    // EL3 is not implemented
    if !HaveEL(EL3) && SSC IN {'01','10'} && HMC:SSC:PxC != '10100' then
        reserved = TRUE;

    // EL3 using AArch64 only
    if (!HaveEL(EL3) || HighestELUsingAArch32()) && HMC:SSC:PxC == '11000' then
        reserved = TRUE;

    // EL2 is not implemented
    if !HaveEL(EL2) && HMC:SSC:PxC == '11100' then
        reserved = TRUE;

    // Secure EL2 is not implemented
    if !HaveSecureEL2Ext() && (HMC:SSC:PxC)  IN {'01100','10100','x11x1'} then
        reserved = TRUE;

    // Values that are not allocated in any architecture version
    if (HMC:SSC:PxC) IN {'01110','100x0','10110','11x10'} then
        reserved = TRUE;

    if reserved then
        // If parameters are set to a reserved type, behaves as either disabled or a defined type
        (c, <HMC,SSC,PxC>) = ConstrainUnpredictableBits(Unpredictable_RESBPWPCTRL);
        assert c IN {Constraint_DISABLED, Constraint_UNKNOWN};
        if c == Constraint_DISABLED then
            return (c, bits(2) UNKNOWN, bit UNKNOWN, bits(2) UNKNOWN);
        // Otherwise the value returned by ConstrainUnpredictableBits must be a not-reserved value

    return (Constraint_NONE, SSC, HMC, PxC);
```

Library pseudocode for aarch64/debug/enables/AArch64.GenerateDebugExceptions

```
// AArch64.GenerateDebugExceptions()
// =================================

boolean AArch64.GenerateDebugExceptions()
    return AArch64.GenerateDebugExceptionsFrom(PSTATE.EL, IsSecure(), PSTATE.D);
```

Library pseudocode for aarch64/debug/enables/AArch64.GenerateDebugExceptionsFrom

```
// AArch64.GenerateDebugExceptionsFrom()
// =====================================

boolean AArch64.GenerateDebugExceptionsFrom(bits(2) from, boolean secure, bit mask)

    if OSLSR_EL1.OSLK == '1' || DoubleLockStatus() || Halted() then
        return FALSE;

    route_to_el2 = HaveEL(EL2) && (!secure || IsSecureEL2Enabled()) && (HCR_EL2.TGE == '1' || MDCR_EL2.TD
    target = (if route_to_el2 then EL2 else EL1);

    enabled = !HaveEL(EL3) || !secure || MDCR_EL3.SDD == '0';

    if from == target then
        enabled = enabled && MDSCR_EL1.KDE == '1' && mask == '0';
    else
        enabled = enabled && UInt(target) > UInt(from);

    return enabled;
```

Library pseudocode for aarch64/debug/pmu/AArch64.CheckForPMUOverflow

```
// AArch64.CheckForPMUOverflow()
// =============================
// Signal Performance Monitors overflow IRQ and CTI overflow events

boolean AArch64.CheckForPMUOverflow()

    pmuirq = PMCR_EL0.E == '1' && PMINTENSET_EL1<31> == '1' && PMOVSSET_EL0<31> == '1';
    for n = 0 to UInt(PMCR_EL0.N) - 1
        if HaveEL(EL2) then
            E = (if n < UInt(MDCR_EL2.HPMN) then PMCR_EL0.E else MDCR_EL2.HPME);
        else
            E = PMCR_EL0.E;
        if E == '1' && PMINTENSET_EL1<n> == '1' && PMOVSSET_EL0<n> == '1' then pmuirq = TRUE;

    SetInterruptRequestLevel(InterruptID_PMUIRQ, if pmuirq then HIGH else LOW);

    CTI_SetEventLevel(CrossTriggerIn_PMUOverflow, if pmuirq then HIGH else LOW);

    // The request remains set until the condition is cleared. (For example, an interrupt handler
    // or cross-triggered event handler clears the overflow status flag by writing to PMOVSCLR_EL0.)

    return pmuirq;
```

Library pseudocode for aarch64/debug/pmu/AArch64.CountEvents

```
// AArch64.CountEvents()
// =====================
// Return TRUE if counter "n" should count its event. For the cycle counter, n == 31.

boolean AArch64.CountEvents(integer n)
    assert n == 31 || n < UInt(PMCR_EL0.N);

    // Event counting is disabled in Debug state
    debug = Halted();

    // In Non-secure state, some counters are reserved for EL2
    if HaveEL(EL2) then
        E = if n < UInt(MDCR_EL2.HPMN) || n == 31 then PMCR_EL0.E else MDCR_EL2.HPME;
    else
        E = PMCR_EL0.E;
    enabled = E == '1' && PMCNTENSET_EL0<n> == '1';

    // Event counting in Secure state is prohibited unless any one of:
    // * EL3 is not implemented
    // * EL3 is using AArch64 and MDCR_EL3.SPME == 1
    prohibited =     if ! HaveEL(EL3) && IsSecure() && MDCR_EL3.SPME == '0';

    // Event counting at EL2 is prohibited if all of:
    // * The HPMD Extension is implemented
    // * Executing at EL2
    // * PMNx is not reserved for EL2
    // * MDCR_EL2.HPMD == 1
    if !prohibited &&() then
        // Event counting in Non-secure state is allowed unless all of:
        // * EL2 and the HPMD Extension are implemented
        // * Executing at EL2
        // * PMNx is not reserved for EL2
        // * MDCR_EL2.HPMD == 1
        if HaveEL(EL2) && HaveHPMDExt() && PSTATE.EL == EL2 && (n < UInt(MDCR_EL2.HPMN) || n == 31) then
        prohibited = (MDCR_EL2.HPMD == '1');

    // The IMPLEMENTATION DEFINED authentication interface might override software controls
    if prohibited && !            prohibited = (MDCR_EL2.HPMD == '1');
        else
            prohibited = FALSE;
    else
        // Event counting in Secure state is prohibited unless any one of:
        // * EL3 is not implemented
        // * EL3 is using AArch64 and MDCR_EL3.SPME == 1
        prohibited =HaveEL(EL3) && MDCR_EL3.SPME == '0';

    // The IMPLEMENTATION DEFINED authentication interface might override software controls
    if prohibited && !HaveNoSecurePMUDisableOverride() then
        prohibited = !ExternalSecureNoninvasiveDebugEnabled();

    // For the cycle counter, PMCR_EL0.DP enables counting when otherwise prohibited
    if prohibited && n == 31 then prohibited = (PMCR_EL0.DP == '1');

    // Event counting can be filtered by the {P, U, NSK, NSU, NSH, M, SH} bits
    // Event counting can be filtered by the {P, U, NSK, NSU, NSH, M} bits
    filter = if n == 31 then PMCCFILTR else PMEVTYPER[n];

    P = filter<31>;
    U = filter<30>;
    NSK = if HaveEL(EL3) then filter<29> else '0';
    NSU = if HaveEL(EL3) then filter<28> else '0';
    NSH = if HaveEL(EL2) then filter<27> else '0';
    M = if HaveEL(EL3) then filter<26> else '0';
    SH = if
    case PSTATE.EL of
        when HaveSecureEL2Ext() then filter<24> else '0';

    case PSTATE.EL of
        when EL0 filtered = if IsSecure() then U == '1' else U != NSU;
        when EL1 filtered = if IsSecure() then P == '1' else P != NSK;
```

```
        when EL2 filtered = (if IsSecure() then NSH == SH else NSH == '0');
filtered = (NSH == '0');
        when EL3 filtered = (M != P);

    return !debug && enabled && !prohibited && !filtered;
```

Library pseudocode for aarch64/debug/statisticalprofiling/CheckProfilingBufferAccess

```
// CheckProfilingBufferAccess()
// ============================

SysRegAccess CheckProfilingBufferAccess()
    if !HaveStatisticalProfiling() || PSTATE.EL == EL0 || UsingAArch32() then
        return SysRegAccess_UNDEFINED;

    if PSTATE.EL == EL1 && EL2Enabled() && MDCR_EL2.E2PB<0> != '1' then
        return SysRegAccess_TrapToEL2;

    if HaveEL(EL3) && PSTATE.EL != EL3 && MDCR_EL3.NSPB != SCR_EL3.NS:'1' then
        return SysRegAccess_TrapToEL3;

    return SysRegAccess_OK;
```

Library pseudocode for aarch64/debug/statisticalprofiling/CheckStatisticalProfilingAccess

```
// CheckStatisticalProfilingAccess()
// =================================

SysRegAccess CheckStatisticalProfilingAccess()
    if !HaveStatisticalProfiling() || PSTATE.EL == EL0 || UsingAArch32() then
        return SysRegAccess_UNDEFINED;

    if PSTATE.EL == EL1 && EL2Enabled() && MDCR_EL2.TPMS == '1' then
        return SysRegAccess_TrapToEL2;

    if HaveEL(EL3) && PSTATE.EL != EL3 && MDCR_EL3.NSPB != SCR_EL3.NS:'1' then
        return SysRegAccess_TrapToEL3;

    return SysRegAccess_OK;
```

Library pseudocode for aarch64/debug/statisticalprofiling/CollectContextIDR1

```
// CollectContextIDR1()
// ====================

boolean CollectContextIDR1()
    if !StatisticalProfilingEnabled() then return FALSE;
    if  PSTATE.EL == EL2 then return FALSE;
    if EL2Enabled() && HCR_EL2.TGE == '1' then return FALSE;
    return PMSCR_EL1.CX == '1';
```

Library pseudocode for aarch64/debug/statisticalprofiling/CollectContextIDR2

```
// CollectContextIDR2()
// ====================

boolean CollectContextIDR2()
    if !StatisticalProfilingEnabled() then return FALSE;
    if  EL2Enabled() then return FALSE;
    return PMSCR_EL2.CX == '1';
```

Library pseudocode for aarch64/debug/statisticalprofiling/CollectPhysicalAddress

```
// CollectPhysicalAddress()
// ========================

boolean CollectPhysicalAddress()
    if !StatisticalProfilingEnabled() then return FALSE;
    (secure, el) = ProfilingBufferOwner();
    if !secure && HaveEL(EL2) then
        return PMSCR_EL2.PA == '1' && (el == EL2 || PMSCR_EL1.PA == '1');
    else
        return PMSCR_EL1.PA == '1';
```

Library pseudocode for aarch64/debug/statisticalprofiling/CollectRecord

```
// CollectRecord()
// ===============

boolean CollectRecord(bits(64) events, integer total_latency, OpType optype)
    assert StatisticalProfilingEnabled();

    // Filtering by event
    if PMSFCR_EL1.FE == '1' then
        e = events<63:48,31:24,15:12,7,5,3,1>;
        m = PMSEVFR_EL1<63:48,31:24,15:12,7,5,3,1>;
        // Check for UNPREDICTABLE case
        if IsZero(PMSEVFR_EL1) && ConstrainUnpredictableBool(Unpredictable_ZEROPMSEVFR) then
            return FALSE;
        bits(64) mask = 0xFFFF0000FF00F0AA<63:0>;   // Bits [63:48,31:24,15:12,7,5,3,1]
        if) then return FALSE;
        if ! HaveStatisticalProfiling() then
            mask<11> = '1';                         // Alignment flag
            if HaveSVE() then mask<18:17> = Ones(); // Predicate flags
        e = events AND mask;
        m = PMSEVFR_EL1 AND mask;
        if !IsZero(NOT(e) AND m) then return FALSE;

    // Filtering by type
    if PMSFCR_EL1.FT == '1' then
        // Check for UNPREDICTABLE case
        if IsZero(PMSFCR_EL1.<B,LD,ST>) && ConstrainUnpredictableBool(Unpredictable_NOOPTYPES) then
            return FALSE;
        case optype of
            when OpType_Branch
                if PMSFCR_EL1.B == '0' then return FALSE;
            when OpType_Load
                if PMSFCR_EL1.LD == '0' then return FALSE;
            when OpType_Store
                if PMSFCR_EL1.ST == '0' then return FALSE;
            when OpType_LoadAtomic
                if PMSFCR_EL1.<LD,ST> == '00' then return FALSE;
            otherwise
                return FALSE;

    // Filtering by latency
            otherwise return FALSE;
    if PMSFCR_EL1.FL == '1' then
        // Check for UNPREDICTABLE case
        if IsZero(PMSLATFR_EL1.MINLAT) && ConstrainUnpredictableBool(Unpredictable_ZEROMINLATENCY) then
) then // UNPREDICTABLE case
            return FALSE;
        if total_latency < UInt(PMSLATFR_EL1.MINLAT) then
            return FALSE;

    return TRUE;
```

Library pseudocode for aarch64/debug/statisticalprofiling/CollectTimeStamp

```
// CollectTimeStamp()
// ==================

TimeStamp CollectTimeStamp()
    if !StatisticalProfilingEnabled() then return TimeStamp_None;
    (secure, el) = ProfilingBufferOwner();
    if el == EL2 then
        if PMSCR_EL2.TS == '0' then return TimeStamp_None;
    else
        if PMSCR_EL1.TS == '0' then return TimeStamp_None;
    if EL2Enabled() then
        pct = PMSCR_EL2.PCT == '1' && (el == EL2 || PMSCR_EL1.PCT == '1');
    else
        pct = PMSCR_EL1.PCT == '1';
    return (if pct then TimeStamp_Physical else TimeStamp_Virtual);
```

Library pseudocode for aarch64/debug/statisticalprofiling/OpType

```
enumeration OpType {
 OpType_Load,                 // Any memory-read operation other than atomics, compare-and-swap, and swap
 OpType_Store,                // Any memory-write operation, including atomics without return
 OpType_LoadAtomic,           // Atomics with return, compare-and-swap and swap
 OpType_Branch,               // Software write to the PC
 OpType_Other                 // Any other class of operation
 };
```

Library pseudocode for aarch64/debug/statisticalprofiling/ProfilingBufferEnabled

```
// ProfilingBufferEnabled()
// ========================

boolean ProfilingBufferEnabled()
    if !HaveStatisticalProfiling() then return FALSE;
    (secure, el) = ProfilingBufferOwner();
    non_secure_bit = if secure then '0' else '1';
    return (!ELUsingAArch32(el) && non_secure_bit == SCR_EL3.NS &&
            PMBLIMITR_EL1.E == '1' && PMBSR_EL1.S == '0');
```

Library pseudocode for aarch64/debug/statisticalprofiling/ProfilingBufferOwner

```
// ProfilingBufferOwner()
// ======================

(boolean, bits(2)) ProfilingBufferOwner()
    secure = if HaveEL(EL3) then (MDCR_EL3.NSPB<1> == '0') else IsSecure();
    el = if !secure && HaveEL(EL2) && MDCR_EL2.E2PB == '00' then EL2 else EL1;
    return (secure, el);
```

Library pseudocode for aarch64/debug/statisticalprofiling/ProfilingSynchronizationBarrier

```
// Barrier to ensure that all existing profiling data has been formatted, and profiling buffer
// addresses have been translated such that writes to the profiling buffer have been initiated.
// A following DSB completes when writes to the profiling buffer have completed.
ProfilingSynchronizationBarrier();
```

Library pseudocode for aarch64/debug/statisticalprofiling/StatisticalProfilingEnabled

```
// StatisticalProfilingEnabled()
// =============================

boolean StatisticalProfilingEnabled()
    if !HaveStatisticalProfiling() || UsingAArch32() || !ProfilingBufferEnabled() then
        return FALSE;

    in_host = EL2Enabled() && HCR_EL2.TGE == '1';
    (secure, el) = ProfilingBufferOwner();
    if UInt(el) <  UInt(PSTATE.EL) || secure != IsSecure() || (in_host && el == EL1)  then
        return FALSE;

    case PSTATE.EL of
        when EL3  Unreachable();
        when EL2  spe_bit = PMSCR_EL2.E2SPE;
        when EL1  spe_bit = PMSCR_EL1.E1SPE;
        when EL0  spe_bit = (if in_host then PMSCR_EL2.E0HSPE else PMSCR_EL1.E0SPE);

    return spe_bit == '1';
```

Library pseudocode for aarch64/debug/statisticalprofiling/SysRegAccess

```
enumeration SysRegAccess { SysRegAccess_OK,
                           SysRegAccess_UNDEFINED,
                           SysRegAccess_TrapToEL1,
                           SysRegAccess_TrapToEL2,
                           SysRegAccess_TrapToEL3 };
```

Library pseudocode for aarch64/debug/statisticalprofiling/TimeStamp

```
enumeration TimeStamp {
    TimeStamp_None,         // No timestamp
    TimeStamp_CoreSight,    // CoreSight time (IMPLEMENTATION DEFINED)
    TimeStamp_Virtual,      // Physical counter value minus CNTVOFF_EL2
    TimeStamp_Physical };   // Physical counter value with no offset
```

Library pseudocode for aarch64/debug/takeexceptiondbg/AArch64.TakeExceptionInDebugState

```
// AArch64.TakeExceptionInDebugState()
// ===================================
// Take an exception in Debug state to an Exception Level using AArch64.

AArch64.TakeExceptionInDebugState(bits(2) target_el, ExceptionRecord exception)
    assert HaveEL(target_el) && !ELUsingAArch32(target_el) && UInt(target_el) >= UInt(PSTATE.EL);

    sync_errors = HaveIESB() && SCTLR[].IESB == '1';
    if HaveDoubleFaultExt() then
        sync_errors = sync_errors || (SCR_EL3.EA == '1' && SCR_EL3.NMEA == '1' && PSTATE.EL == EL3);
    // SCTLR[].IESB might be ignored in Debug state.
    if !ConstrainUnpredictableBool(Unpredictable_IESBinDebug) then
        sync_errors = FALSE;

    if TSTATE.depth > 0 then
        case exception.exceptype of
            when Exception_SoftwareBreakpoint cause = TMFailure_DBG;
            when Exception_Breakpoint         cause = TMFailure_DBG;
            when Exception_Watchpoint         cause = TMFailure_DBG;
            when Exception_SoftwareStep       cause = TMFailure_DBG;
            otherwise                         cause = TMFailure_ERR;
        FailTransaction(cause, FALSE);

    SynchronizeContext();

    // If coming from AArch32 state, the top parts of the X[] registers might be set to zero
    from_32 = UsingAArch32();
    if from_32 then AArch64.MaybeZeroRegisterUppers();
    MaybeZeroSVEUppers(target_el);

    AArch64.ReportException(exception, target_el);

    PSTATE.EL = target_el;
    PSTATE.nRW = '0';
    PSTATE.SP = '1';

    SPSR[] = bits(32) UNKNOWN;
    ELR[] = bits(64) UNKNOWN;

    // PSTATE.{SS,D,A,I,F} are not observable and ignored in Debug state, so behave as if UNKNOWN.
    PSTATE.<SS,D,A,I,F> = bits(5) UNKNOWN;
    PSTATE.IL = '0';
    if from_32 then                             // Coming from AArch32
        PSTATE.IT = '00000000';
        PSTATE.T = '0';                         // PSTATE.J is RES0
    if (HavePANExt() && (PSTATE.EL == EL1 || (PSTATE.EL == EL2 && ELIsInHost(EL0))) &&
        SCTLR[].SPAN == '0') then
        PSTATE.PAN = '1';
    if HaveUAOExt() then PSTATE.UAO = '0';
    if HaveBTIExt() then PSTATE.BTYPE = '00';
    if HaveSSBSExt() then PSTATE.SSBS = bit UNKNOWN;
    if HaveMTEExt() then PSTATE.TCO = '1';

    DLR_EL0 = bits(64) UNKNOWN;
    DSPSR_EL0 = bits(32) UNKNOWN;

    EDSCR.ERR = '1';
    UpdateEDSCRFields();                        // Update EDSCR processor state flags.

    if sync_errors then
        SynchronizeErrors();

    EndOfInstruction();
```

Library pseudocode for aarch64/debug/watchpoint/AArch64.WatchpointByteMatch

```
// AArch64.WatchpointByteMatch()
// =============================

boolean AArch64.WatchpointByteMatch(integer n, AccType acctype, bits(64) vaddress)

    el = if HaveNV2Ext() && acctype == AccType_NV2REGISTER then EL2 else PSTATE.EL;
    top = AddrTop(vaddress, FALSE, el);
    bottom = if DBGWVR_EL1[n]<2> == '1' then 2 else 3;            // Word or doubleword
    byte_select_match = (DBGWCR_EL1[n].BAS<UInt(vaddress<bottom-1:0>)> != '0');
    mask = UInt(DBGWCR_EL1[n].MASK);

    // If DBGWCR_EL1[n].MASK is non-zero value and DBGWCR_EL1[n].BAS is not set to '11111111', or
    // DBGWCR_EL1[n].BAS specifies a non-contiguous set of bytes behavior is CONSTRAINED
    // UNPREDICTABLE.
    if mask > 0 && !IsOnes(DBGWCR_EL1[n].BAS) then
        byte_select_match = ConstrainUnpredictableBool(Unpredictable_WPMASKANDBAS);
    else
        LSB = (DBGWCR_EL1[n].BAS AND NOT(DBGWCR_EL1[n].BAS - 1));  MSB = (DBGWCR_EL1[n].BAS + LSB);
        if !IsZero(MSB AND (MSB - 1)) then                        // Not contiguous
            byte_select_match = ConstrainUnpredictableBool(Unpredictable_WPBASCONTIGUOUS);
            bottom = 3;                                           // For the whole doubleword

    // If the address mask is set to a reserved value, the behavior is CONSTRAINED UNPREDICTABLE.
    if mask > 0 && mask <= 2 then
        (c, mask) = ConstrainUnpredictableInteger(3, 31, Unpredictable_RESWPMASK);
        assert c IN {Constraint_DISABLED, Constraint_NONE, Constraint_UNKNOWN};
        case c of
            when Constraint_DISABLED  return FALSE;               // Disabled
            when Constraint_NONE      mask = 0;                   // No masking
            // Otherwise the value returned by ConstrainUnpredictableInteger is a not-reserved value

    if mask > bottom then
        WVR_match = (vaddress<top:mask> == DBGWVR_EL1[n]<top:mask>);
        // If masked bits of DBGWVR_EL1[n] are not zero, the behavior is CONSTRAINED UNPREDICTABLE.
        if WVR_match && !IsZero(DBGWVR_EL1[n]<mask-1:bottom>) then
            WVR_match = ConstrainUnpredictableBool(Unpredictable_WPMASKEDBITS);
    else
        WVR_match = vaddress<top:bottom> == DBGWVR_EL1[n]<top:bottom>;

    return WVR_match && byte_select_match;
```

Library pseudocode for aarch64/debug/watchpoint/AArch64.WatchpointMatch

```
// AArch64.WatchpointMatch()
// =========================
// Watchpoint matching in an AArch64 translation regime.

boolean AArch64.WatchpointMatch(integer n, bits(64) vaddress, integer size, boolean ispriv,
                                AccType acctype, boolean iswrite)
    assert !ELUsingAArch32(S1TranslationRegime());
    assert n <= UInt(ID_AA64DFR0_EL1.WRPs);

    // "ispriv" is FALSE for LDTR/STTR instructions executed at EL1 and all
    // load/stores at EL0, TRUE for all other load/stores. "iswrite" is TRUE for stores, FALSE for
    // loads.
    enabled = DBGWCR_EL1[n].E == '1';
    linked = DBGWCR_EL1[n].WT == '1';
    isbreakpnt = FALSE;

    state_match = AArch64.StateMatch(DBGWCR_EL1[n].SSC, DBGWCR_EL1[n].HMC, DBGWCR_EL1[n].PAC,
                                     linked, DBGWCR_EL1[n].LBN, isbreakpnt, acctype, ispriv);

    ls_match = (DBGWCR_EL1[n].LSC<(if iswrite then 1 else 0)> == '1');

    value_match = FALSE;
    for byte = 0 to size - 1
        value_match = value_match || AArch64.WatchpointByteMatch(n, acctype, vaddress + byte);

    return value_match && state_match && ls_match && enabled;
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.Abort

```
// AArch64.Abort()
// ===============
// Abort and Debug exception handling in an AArch64 translation regime.

AArch64.Abort(bits(64) vaddress, FaultRecord fault)

    if IsDebugException(fault) then
        if fault.acctype == AccType_IFETCH then
            if UsingAArch32() && fault.debugmoe == DebugException_VectorCatch then
                AArch64.VectorCatchException(fault);
            else
                AArch64.BreakpointException(fault);
        else
            AArch64.WatchpointException(vaddress, fault);
    elsif fault.acctype == AccType_IFETCH then
        AArch64.InstructionAbort(vaddress, fault);
    else
        AArch64.DataAbort(vaddress, fault);
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.AbortSyndrome

```
// AArch64.AbortSyndrome()
// =======================
// Creates an exception syndrome record for Abort and Watchpoint exceptions
// from an AArch64 translation regime.

ExceptionRecord AArch64.AbortSyndrome(Exception exceptype, FaultRecord fault, bits(64) vaddress)
    exception = ExceptionSyndrome(exceptype);

    d_side = exceptype IN {Exception_DataAbort, Exception_NV2DataAbort, Exception_Watchpoint,};

    exception.syndrome = Exception_NV2Watchpoint};

    exception.syndrome = AArch64.FaultSyndrome(d_side, fault);
    exception.vaddress = ZeroExtend(vaddress);
    if IPAValid(fault) then
        exception.ipavalid = TRUE;
        exception.NS = fault.ipaddress.NS;
        exception.ipaddress = fault.ipaddress.address;
    else
        exception.ipavalid = FALSE;

    return exception;
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.CheckPCAlignment

```
// AArch64.CheckPCAlignment()
// ==========================

AArch64.CheckPCAlignment()

    bits(64) pc = ThisInstrAddr();
    if pc<1:0> != '00' then
        AArch64.PCAlignmentFault();
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.DataAbort

```
// AArch64.DataAbort()
// ===================

AArch64.DataAbort(bits(64) vaddress, FaultRecord fault)
    route_to_el3 = HaveEL(EL3) && SCR_EL3.EA == '1' && IsExternalAbort(fault);
    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() && (HCR_EL2.TGE == '1' ||
                    (HaveRASExt() && HCR_EL2.TEA == '1' && IsExternalAbort(fault)) ||
                    (HaveNV2Ext() && fault.acctype == AccType_NV2REGISTER) ||
                    IsSecondStage(fault)));

    bits(64) preferred_exception_return = ThisInstrAddr();
    if (HaveDoubleFaultExt() && (PSTATE.EL == EL3 || route_to_el3) &&
        IsExternalAbort(fault) && SCR_EL3.EASE == '1') then
        vect_offset = 0x180;
    else
        vect_offset = 0x0;
    if HaveNV2Ext() && fault.acctype == AccType_NV2REGISTER then
        exception = AArch64.AbortSyndrome(Exception_NV2DataAbort, fault, vaddress);
    else
        exception = AArch64.AbortSyndrome(Exception_DataAbort, fault, vaddress);
    if PSTATE.EL == EL3 || route_to_el3 then
        AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.EffectiveTCF

```
// AArch64.EffectiveTCF()
// ======================
// Returns the TCF field applied to Tag Check Fails in the given Exception Level.

bits(2) AArch64.EffectiveTCF(bits(2) el)
    bits(2) tcf;

    if el == EL3 then
        tcf = SCTLR_EL3.TCF;
    elsif el == EL2 then
        tcf = SCTLR_EL2.TCF;
    elsif el == EL1 then
        tcf = SCTLR_EL1.TCF;
    elsif el == EL0 && HCR_EL2.<E2H,TGE> == '11' then
        tcf = SCTLR_EL2.TCF0;
    elsif el == EL0 && HCR_EL2.<E2H,TGE> != '11' then
        tcf = SCTLR_EL1.TCF0;

    if tcf == '11' then
        (-,tcf) =     return tcf; ConstrainUnpredictableBits(Unpredictable_RESTCF);

    return tcf;
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.InstructionAbort

```
// AArch64.InstructionAbort()
// ==========================

AArch64.InstructionAbort(bits(64) vaddress, FaultRecord fault)
    // External aborts on instruction fetch must be taken synchronously
    if HaveDoubleFaultExt() then assert fault.statuscode != Fault_AsyncExternal;
    route_to_el3 = HaveEL(EL3) && SCR_EL3.EA == '1' && IsExternalAbort(fault);
    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || IsSecondStage(fault) ||
                    (HaveRASExt() && HCR_EL2.TEA == '1' && IsExternalAbort(fault))));

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = AArch64.AbortSyndrome(Exception_InstructionAbort, fault, vaddress);

    if PSTATE.EL == EL3 || route_to_el3 then
        AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.PCAlignmentFault

```
// AArch64.PCAlignmentFault()
// ==========================
// Called on unaligned program counter in AArch64 state.

AArch64.PCAlignmentFault()

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_PCAlignment);
    exception.vaddress = ThisInstrAddr();

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif EL2Enabled() && HCR_EL2.TGE == '1' then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.ReportTagCheckFail

```
// AArch64.ReportTagCheckFail()
// ============================
// Records a tag fail exception into the appropriate TCFR_ELx.

AArch64.ReportTagCheckFail(bits(2) el, bit ttbr)
    if el == EL3 then
        assert ttbr == '0';
        TFSR_EL3.TF0 = '1';
    elsif el == EL2 then
        if ttbr == '0' then
            TFSR_EL2.TF0 = '1';
        else
            TFSR_EL2.TF1 = '1';
    elsif el == EL1 then
        if ttbr == '0' then
            TFSR_EL1.TF0 = '1';
        else
            TFSR_EL1.TF1 = '1';
    elsif el == EL0 then
        if ttbr == '0' then
            TFSRE0_EL1.TF0 = '1';
        else
            TFSRE0_EL1.TF1 = '1';
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.SPAlignmentFault

```
// AArch64.SPAlignmentFault()
// ==========================
// Called on an unaligned stack pointer in AArch64 state.

AArch64.SPAlignmentFault()

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_SPAlignment);

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif EL2Enabled() && HCR_EL2.TGE == '1' then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.TagCheckFail

```
// AArch64.TagCheckFail()
// ======================
// Handle a tag check fail condition.

AArch64.TagCheckFail(bits(64) vaddress, boolean iswrite)
    bits(2) tcf = AArch64.EffectiveTCF(PSTATE.EL);
    if tcf == '01' then
        AArch64.TagCheckFault(vaddress, iswrite);
    elsif tcf == '10' then
        AArch64.ReportTagCheckFail(PSTATE.EL, vaddress<55>);
```

Library pseudocode for aarch64/exceptions/aborts/AArch64.TagCheckFault

```
// AArch64.TagCheckFault()
// =======================
// Raise a tag check fail exception.

AArch64.TagCheckFault(bits(64) va, boolean write)
    bits(2) target_el;
    bits(64) preferred_exception_return = ThisInstrAddr();
    integer vect_offset = 0x0;

    if PSTATE.EL == EL0 then
        target_el = if HCR_EL2.TGE == '0' then EL1 else EL2;
    else
        target_el = PSTATE.EL;

    exception = ExceptionSyndrome(Exception_DataAbort);
    exception.syndrome<5:0> = '010001';
    if write then
        exception.syndrome<6> = '1';
    exception.vaddress = va;

    AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/aborts/BranchTargetException

```
// BranchTargetException
// =====================
// Raise branch target exception.

AArch64.BranchTargetException(bits(52) vaddress)

    route_to_el2 = PSTATE.EL == EL0 && EL2Enabled() && HCR_EL2.TGE == '1';
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_BranchTarget);
    exception.syndrome<1:0>   = PSTATE.BTYPE;
    exception.syndrome<24:2>  = Zeros();         // RES0

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/asynch/AArch64.TakePhysicalFIQException

```
// AArch64.TakePhysicalFIQException()
// ==================================

AArch64.TakePhysicalFIQException()

    route_to_el3 = HaveEL(EL3) && SCR_EL3.FIQ == '1';
    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || HCR_EL2.FMO == '1'));
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x100;
    exception = ExceptionSyndrome(Exception_FIQ);

    if route_to_el3 then
        AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_el2 then
        assert PSTATE.EL != EL3;
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        assert PSTATE.EL IN {EL0, EL1};
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/asynch/AArch64.TakePhysicalIRQException

```
// AArch64.TakePhysicalIRQException()
// ==================================
// Take an enabled physical IRQ exception.

AArch64.TakePhysicalIRQException()

    route_to_el3 = HaveEL(EL3) && SCR_EL3.IRQ == '1';
    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || HCR_EL2.IMO == '1'));
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x80;

    exception = ExceptionSyndrome(Exception_IRQ);

    if route_to_el3 then
        AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_el2 then
        assert PSTATE.EL != EL3;
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        assert PSTATE.EL IN {EL0, EL1};
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/asynch/AArch64.TakePhysicalSErrorException

```
// AArch64.TakePhysicalSErrorException()
// =====================================

AArch64.TakePhysicalSErrorException(boolean impdef_syndrome, bits(24) syndrome)

    route_to_el3 = HaveEL(EL3) && SCR_EL3.EA == '1';
    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || (!IsInHost() && HCR_EL2.AMO == '1')));
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x180;

    exception = ExceptionSyndrome(Exception_SError);
    exception.syndrome<24> = if impdef_syndrome then '1' else '0';
    exception.syndrome<23:0> = syndrome;

    ClearPendingPhysicalSError();

    if PSTATE.EL == EL3 || route_to_el3 then
        AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
    elsif PSTATE.EL == EL2 || route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/asynch/AArch64.TakeVirtualFIQException

```
// AArch64.TakeVirtualFIQException()
// =================================

AArch64.TakeVirtualFIQException()
    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();
    assert HCR_EL2.TGE == '0' && HCR_EL2.FMO == '1';  // Virtual IRQ enabled if TGE==0 and FMO==1

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x100;

    exception = ExceptionSyndrome(Exception_FIQ);

    AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/asynch/AArch64.TakeVirtualIRQException

```
// AArch64.TakeVirtualIRQException()
// =================================

AArch64.TakeVirtualIRQException()
    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();
    assert HCR_EL2.TGE == '0' && HCR_EL2.IMO == '1';  // Virtual IRQ enabled if TGE==0 and IMO==1

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x80;

    exception = ExceptionSyndrome(Exception_IRQ);

    AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/asynch/AArch64.TakeVirtualSErrorException

```
// AArch64.TakeVirtualSErrorException()
// ====================================

AArch64.TakeVirtualSErrorException(boolean impdef_syndrome, bits(24) syndrome)

    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();
    assert HCR_EL2.TGE == '0' && HCR_EL2.AMO == '1';  // Virtual SError enabled if TGE==0 and AMO==1

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x180;

    exception = ExceptionSyndrome(Exception_SError);
    if HaveRASExt() then
        exception.syndrome<24>   = VSESR_EL2.IDS;
        exception.syndrome<23:0> = VSESR_EL2.ISS;
    else
        exception.syndrome<24> = if impdef_syndrome then '1' else '0';
        if impdef_syndrome then exception.syndrome<23:0> = syndrome;

    ClearPendingVirtualSError();
    AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/debug/AArch64.BreakpointException

```
// AArch64.BreakpointException()
// =============================

AArch64.BreakpointException(FaultRecord fault)
    assert PSTATE.EL != EL3;

    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || MDCR_EL2.TDE == '1'));

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    vaddress = bits(64) UNKNOWN;
    exception = AArch64.AbortSyndrome(Exception_Breakpoint, fault, vaddress);

    if PSTATE.EL == EL2 || route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/debug/AArch64.SoftwareBreakpoint

```
// AArch64.SoftwareBreakpoint()
// ============================

AArch64.SoftwareBreakpoint(bits(16) immediate)

    route_to_el2 = (PSTATE.EL IN {EL0, EL1} &&
                    EL2Enabled() && (HCR_EL2.TGE == '1' || MDCR_EL2.TDE == '1'));

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_SoftwareBreakpoint);
    exception.syndrome<15:0> = immediate;

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/debug/AArch64.SoftwareStepException

```
// AArch64.SoftwareStepException()
// ===============================

AArch64.SoftwareStepException()
    assert PSTATE.EL != EL3;

    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || MDCR_EL2.TDE == '1'));

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_SoftwareStep);
    if SoftwareStep_DidNotStep() then
        exception.syndrome<24> = '0';
    else
        exception.syndrome<24> = '1';
        exception.syndrome<6> = if SoftwareStep_SteppedEX() then '1' else '0';

    if PSTATE.EL == EL2 || route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/debug/AArch64.VectorCatchException

```
// AArch64.VectorCatchException()
// ==============================
// Vector Catch taken from EL0 or EL1 to EL2. This can only be called when debug exceptions are
// being routed to EL2, as Vector Catch is a legacy debug event.

AArch64.VectorCatchException(FaultRecord fault)
    assert PSTATE.EL != EL2;
    assert EL2Enabled() && (HCR_EL2.TGE == '1' || MDCR_EL2.TDE == '1');

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    vaddress = bits(64) UNKNOWN;
    exception = AArch64.AbortSyndrome(Exception_VectorCatch, fault, vaddress);

    AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/debug/AArch64.WatchpointException

```
// AArch64.WatchpointException()
// =============================

AArch64.WatchpointException(bits(64) vaddress, FaultRecord fault)
    assert PSTATE.EL != EL3;

    route_to_el2 = (PSTATE.EL IN {EL0, EL1} && EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || MDCR_EL2.TDE == '1'));

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    if exception = HaveNV2Ext() && fault.acctype == AccType_NV2REGISTER then
        exception = AArch64.AbortSyndrome(Exception_NV2Watchpoint, fault, vaddress);
    else
        exception = AArch64.AbortSyndrome(Exception_Watchpoint, fault, vaddress);

    if PSTATE.EL == EL2 || route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/exceptions/AArch64.ExceptionClass

```
// AArch64.ExceptionClass()
// ========================
// Returns the Exception Class and Instruction Length fields to be reported in ESR

(integer,bit) AArch64.ExceptionClass(Exception exceptype, bits(2) target_el)

    il = if ThisInstrLength() == 32 then '1' else '0';
    from_32 = UsingAArch32();
    assert from_32 || il == '1';            // AArch64 instructions always 32-bit

    case exceptype of
        when Exception_Uncategorized        ec = 0x00; il = '1';
        when Exception_WFxTrap              ec = 0x01;
        when Exception_CP15RTTrap           ec = 0x03;          assert from_32;
        when Exception_CP15RRTTrap          ec = 0x04;          assert from_32;
        when Exception_CP14RTTrap           ec = 0x05;          assert from_32;
        when Exception_CP14DTTrap           ec = 0x06;          assert from_32;
        when Exception_AdvSIMDFPAccessTrap  ec = 0x07;
        when Exception_FPIDTrap             ec = 0x08;
        when Exception_PACTrap              ec = 0x09;
        when Exception_TSTARTAccessTrap     ec = 0x1B;
        when Exception_CP14RRTTrap          ec = 0x0C;          assert from_32;
        when Exception_BranchTarget         ec = 0x0D;
        when Exception_IllegalState         ec = 0x0E; il = '1';
        when Exception_SupervisorCall       ec = 0x11;
        when Exception_HypervisorCall       ec = 0x12;
        when Exception_MonitorCall          ec = 0x13;
        when Exception_SystemRegisterTrap   ec = 0x18;          assert !from_32;
        when Exception_SVEAccessTrap        ec = 0x19;          assert !from_32;
        when Exception_ERetTrap             ec = 0x1A;
        when Exception_InstructionAbort     ec = 0x20; il = '1';
        when Exception_PCAlignment          ec = 0x22; il = '1';
        when Exception_DataAbort            ec = 0x24;
        when Exception_NV2DataAbort         ec = 0x25;
        when Exception_SPAlignment          ec = 0x26; il = '1'; assert !from_32;
        when Exception_FPTrappedException   ec = 0x28;
        when Exception_SError               ec = 0x2F; il = '1';
        when Exception_Breakpoint           ec = 0x30; il = '1';
        when Exception_SoftwareStep         ec = 0x32; il = '1';
        when Exception_Watchpoint           ec = 0x34; il = '1';
        when Exception_NV2Watchpoint        ec = 0x35; il = '1';
        when Exception_SoftwareBreakpoint   ec = 0x38;
        when Exception_VectorCatch          ec = 0x3A; il = '1'; assert from_32;
        otherwise                           Unreachable();

    if ec IN {0x20,0x24,0x30,0x32,0x34} && target_el == PSTATE.EL then
        ec = ec + 1;

    if ec IN {0x11,0x12,0x13,0x28,0x38} && !from_32 then
        ec = ec + 4;

    return (ec,il);
```

Library pseudocode for aarch64/exceptions/exceptions/AArch64.ReportException

```
// AArch64.ReportException()
// =========================
// Report syndrome information for exception taken to AArch64 state.

AArch64.ReportException(ExceptionRecord exception, bits(2) target_el)

    Exception exceptype = exception.exceptype;

    (ec,il) = AArch64.ExceptionClass(exceptype, target_el);
    iss = exception.syndrome;

    // IL is not valid for Data Abort exceptions without valid instruction syndrome information
    if ec IN {0x24,0x25} && iss<24> == '0' then
        il = '1';

    ESR[target_el] = ec<5:0>:il:iss;

    if exceptype IN {Exception_InstructionAbort, Exception_PCAlignment, Exception_DataAbort,
                Exception_NV2DataAbort, Exception_NV2Watchpoint,
                Exception_Watchpoint} then
        FAR[target_el] = exception.vaddress;
    else
        FAR[target_el] = bits(64) UNKNOWN;

    if target_el == EL2 then
        if exception.ipavalid then
            HPFAR_EL2<43:4> = exception.ipaddress<51:12>;
            if HaveSecureEL2Ext() then
                if IsSecureEL2Enabled() then
                    HPFAR_EL2.NS = exception.NS;
                else
                    HPFAR_EL2.NS = '0';
        else
            HPFAR_EL2<43:4> = bits(40) UNKNOWN;

    return;
```

Library pseudocode for aarch64/exceptions/exceptions/AArch64.ResetControlRegisters

```
// Resets System registers and memory-mapped control registers that have architecturally-defined
// reset values to those values.
AArch64.ResetControlRegisters(boolean cold_reset);
```

Library pseudocode for aarch64/exceptions/exceptions/AArch64.TakeReset

```
// AArch64.TakeReset()
// ===================
// Reset into AArch64 state

AArch64.TakeReset(boolean cold_reset)
    assert !HighestELUsingAArch32();

    // Enter the highest implemented Exception level in AArch64 state
    PSTATE.nRW = '0';
    if HaveEL(EL3) then
        PSTATE.EL = EL3;
    elsif HaveEL(EL2) then
        PSTATE.EL = EL2;
    else
        PSTATE.EL = EL1;

    // Reset the system registers and other system components
    AArch64.ResetControlRegisters(cold_reset);

    // Reset all other PSTATE fields
    PSTATE.SP = '1';              // Select stack pointer
    PSTATE.<D,A,I,F>  = '1111';   // All asynchronous exceptions masked
    PSTATE.SS = '0';              // Clear software step bit
    PSTATE.DIT = '0';             // PSTATE.DIT is reset to 0 when resetting into AArch64
    PSTATE.IL = '0';              // Clear Illegal Execution state bit

    TSTATE.depth = 0;             // Non-transactional state

    // All registers, bits and fields not reset by the above pseudocode or by the BranchTo() call
    // below are UNKNOWN bitstrings after reset. In particular, the return information registers
    // ELR_ELx and SPSR_ELx have UNKNOWN values, so that it
    // is impossible to return from a reset in an architecturally defined way.
    AArch64.ResetGeneralRegisters();
    AArch64.ResetSIMDFPRegisters();
    AArch64.ResetSpecialRegisters();
    ResetExternalDebugRegisters(cold_reset);

    bits(64) rv;                      // IMPLEMENTATION DEFINED reset vector

    if HaveEL(EL3) then
        rv = RVBAR_EL3;
    elsif HaveEL(EL2) then
        rv = RVBAR_EL2;
    else
        rv = RVBAR_EL1;

    // The reset vector must be correctly aligned
    assert IsZero(rv<63:PAMax()>) && IsZero(rv<1:0>);

    BranchTo(rv, BranchType_RESET);
```

Library pseudocode for aarch64/exceptions/ieeefp/AArch64.FPTrappedException

```
// AArch64.FPTrappedException()
// ============================

AArch64.FPTrappedException(boolean is_ase, integer element, bits(8) accumulated_exceptions)
    exception = ExceptionSyndrome(Exception_FPTrappedException);
    if is_ase then
        if boolean IMPLEMENTATION_DEFINED "vector instructions set TFV to 1" then
            exception.syndrome<23> = '1';                           // TFV
        else
            exception.syndrome<23> = '0';                           // TFV
    else
        exception.syndrome<23> = '1';                               // TFV
    exception.syndrome<10:8> = bits(3) UNKNOWN;                     // VECITR
    if exception.syndrome<23> == '1' then
        exception.syndrome<7,4:0> = accumulated_exceptions<7,4:0>; // IDF,IXF,UFF,OFF,DZF,IOF
    else
        exception.syndrome<7,4:0> = bits(6) UNKNOWN;

    route_to_el2 = EL2Enabled() && HCR_EL2.TGE == '1';

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/syscalls/AArch64.CallHypervisor

```
// AArch64.CallHypervisor()
// ========================
// Performs a HVC call

AArch64.CallHypervisor(bits(16) immediate)
    assert HaveEL(EL2);

    if UsingAArch32() then AArch32.ITAdvance();
    SSAdvance();
    bits(64) preferred_exception_return = NextInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_HypervisorCall);
    exception.syndrome<15:0> = immediate;

    if PSTATE.EL == EL3 then
        AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/syscalls/AArch64.CallSecureMonitor

```
// AArch64.CallSecureMonitor()
// ===========================

AArch64.CallSecureMonitor(bits(16) immediate)
    assert HaveEL(EL3) && !ELUsingAArch32(EL3);
    if UsingAArch32() then AArch32.ITAdvance();
    SSAdvance();
    bits(64) preferred_exception_return = NextInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_MonitorCall);
    exception.syndrome<15:0> = immediate;

    AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/syscalls/AArch64.CallSupervisor

```
// AArch64.CallSupervisor()
// ========================
// Calls the Supervisor

AArch64.CallSupervisor(bits(16) immediate)

    if UsingAArch32() then AArch32.ITAdvance();
    SSAdvance();
    route_to_el2 = PSTATE.EL == EL0 && EL2Enabled() && HCR_EL2.TGE == '1';

    bits(64) preferred_exception_return = NextInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_SupervisorCall);
    exception.syndrome<15:0> = immediate;

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/takeexception/AArch64.TakeException

```
// AArch64.TakeException()
// =======================
// Take an exception to an Exception Level using AArch64.

AArch64.TakeException(bits(2) target_el, ExceptionRecord exception,
                      bits(64) preferred_exception_return, integer vect_offset)
    assert HaveEL(target_el) && !ELUsingAArch32(target_el) && UInt(target_el) >= UInt(PSTATE.EL);

    sync_errors = HaveIESB() && SCTLR[].IESB == '1';
    if HaveDoubleFaultExt() then
        sync_errors = sync_errors || (SCR_EL3.EA == '1' && SCR_EL3.NMEA == '1' && PSTATE.EL == EL3);
    if sync_errors && InsertIESBBeforeException(target_el) then
        SynchronizeErrors();
        iesb_req = FALSE;
        sync_errors = FALSE;
        TakeUnmaskedPhysicalSErrorInterrupts(iesb_req);

    if TSTATE.depth > 0 then
        case exception.exceptype of
            when Exception_SoftwareBreakpoint cause = TMFailure_DBG;
            when Exception_Breakpoint         cause = TMFailure_DBG;
            when Exception_Watchpoint         cause = TMFailure_DBG;
            when Exception_SoftwareStep       cause = TMFailure_DBG;
            otherwise                         cause = TMFailure_ERR;
        FailTransaction(cause, FALSE);

    SynchronizeContext();

    // If coming from AArch32 state, the top parts of the X[] registers might be set to zero
    from_32 = UsingAArch32();
    if from_32 then AArch64.MaybeZeroRegisterUppers();
    MaybeZeroSVEUppers(target_el);

    if UInt(target_el) > UInt(PSTATE.EL) then
        boolean lower_32;
        if target_el == EL3 then
            if EL2Enabled() then
                lower_32 = ELUsingAArch32(EL2);
            else
                lower_32 = ELUsingAArch32(EL1);
        elsif IsInHost() && PSTATE.EL == EL0 && target_el == EL2 then
            lower_32 = ELUsingAArch32(EL0);
        else
            lower_32 = ELUsingAArch32(target_el - 1);
        vect_offset = vect_offset + (if lower_32 then 0x600 else 0x400);

    elsif PSTATE.SP == '1' then
        vect_offset = vect_offset + 0x200;

    spsr = GetPSRFromPSTATE();

    if HaveNVExt() && PSTATE.EL == EL1 && target_el == EL1 && EL2Enabled() && HCR_EL2.<NV,NV1> == '10' th
        spsr<3:2> = '10';

    if HaveBTIExt() then
        // SPSR[].BTYPE is only guaranteed valid for these exception types
        if exception.exceptype IN {Exception_SError, Exception_IRQ, Exception_FIQ,
                                   Exception_SoftwareStep, Exception_PCAlignment,
                                   Exception_InstructionAbort, Exception_Breakpoint,
                                   Exception_VectorCatch, Exception_SoftwareBreakpoint,
                                   Exception_IllegalState, Exception_BranchTarget} then
            zero_btype = FALSE;
        else
            zero_btype = ConstrainUnpredictableBool(Unpredictable_ZEROBTYPE);
        if zero_btype then spsr<11:10> = '00';

    if HaveNV2Ext() && exception.exceptype == Exception_NV2DataAbort && target_el == EL3 then
        // external aborts are configured to be taken to EL3
        exception.exceptype = Exception_DataAbort;
    if !(exception.exceptype IN {Exception_IRQ, Exception_FIQ}) then
```

```
        AArch64.ReportException(exception, target_el);

    PSTATE.EL = target_el;
    PSTATE.nRW = '0';
    PSTATE.SP = '1';

    SPSR[] = spsr;
    ELR[] = preferred_exception_return;

    PSTATE.SS = '0';
    PSTATE.<D,A,I,F> = '1111';
    PSTATE.IL = '0';
    if from_32 then                             // Coming from AArch32
        PSTATE.IT = '00000000';
        PSTATE.T = '0';                         // PSTATE.J is RES0
    if (HavePANExt() && (PSTATE.EL == EL1 || (PSTATE.EL == EL2 && ELIsInHost(EL0))) &&
        SCTLR[].SPAN == '0') then
        PSTATE.PAN = '1';
    if HaveUAOExt() then PSTATE.UAO = '0';
    if HaveBTIExt() then PSTATE.BTYPE = '00';
    if HaveSSBSExt() then PSTATE.SSBS = SCTLR[].DSSBS;
    if HaveMTEExt() then PSTATE.TCO = '1';

    BranchTo(VBAR[]<63:11>:vect_offset<10:0>, BranchType_EXCEPTION);

    if sync_errors then
        SynchronizeErrors();
        iesb_req = TRUE;
        TakeUnmaskedPhysicalSErrorInterrupts(iesb_req);

    EndOfInstruction();
```

Library pseudocode for aarch64/exceptions/traps/AArch64.AArch32SystemAccessTrap

```
// AArch64.AArch32SystemAccessTrap()
// =================================
// Trapped AARCH32 system register access.

AArch64.AArch32SystemAccessTrap(bits(2) target_el, integer ec)
    assert HaveEL(target_el) && target_el != EL0 && UInt(target_el) >= UInt(PSTATE.EL);

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = AArch64.AArch32SystemAccessTrapSyndrome(ThisInstr(), ec);
    AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.AArch32SystemAccessTrapSyndrome

```
// AArch64.AArch32SystemAccessTrapSyndrome()
// =========================================
// Returns the syndrome information for traps on AArch32 MCR, MCRR, MRC, MRRC, and VMRS, VMSR instruction
// other than traps that are due to HCPTR or CPACR.

ExceptionRecord AArch64.AArch32SystemAccessTrapSyndrome(bits(32) instr, integer ec)
    ExceptionRecord exception;

    case ec of
        when 0x0    exception = ExceptionSyndrome(Exception_Uncategorized);
        when 0x3    exception = ExceptionSyndrome(Exception_CP15RTTrap);
        when 0x4    exception = ExceptionSyndrome(Exception_CP15RRTTrap);
        when 0x5    exception = ExceptionSyndrome(Exception_CP14RTTrap);
        when 0x6    exception = ExceptionSyndrome(Exception_CP14DTTrap);
        when 0x7    exception = ExceptionSyndrome(Exception_AdvSIMDFPAccessTrap);
        when 0x8    exception = ExceptionSyndrome(Exception_FPIDTrap);
        when 0xC    exception = ExceptionSyndrome(Exception_CP14RRTTrap);
        otherwise   Unreachable();

    bits(20) iss = Zeros();

    if exception.exceptype IN {Exception_FPIDTrap, Exception_CP14RTTrap, Exception_CP15RTTrap} then
        // Trapped MRC/MCR, VMRS on FPSID
        if exception.exceptype != Exception_FPIDTrap then    // When trap is not for VMRS
            iss<19:17> = instr<7:5>;           // opc2
            iss<16:14> = instr<23:21>;         // opc1
            iss<13:10> = instr<19:16>;         // CRn
            iss<4:1>   = instr<3:0>;           // CRm
        else
            iss<19:17> = '000';
            iss<16:14> = '111';
            iss<13:10> = instr<19:16>;         // reg
            iss<4:1>   = '0000';

        if instr<20> == '1' && instr<15:12> == '1111' then    // MRC, Rt==15
            iss<9:5> = '11111';
        elsif instr<20> == '0' && instr<15:12> == '1111' then // MCR, Rt==15
            iss<9:5> = bits(5) UNKNOWN;
        else
            iss<9:5> = LookUpRIndex(UInt(instr<15:12>), PSTATE.M)<4:0>;
    elsif exception.exceptype IN {Exception_CP14RRTTrap, Exception_AdvSIMDFPAccessTrap, Exception_CP15RRT
        // Trapped MRRC/MCRR, VMRS/VMSR
        iss<19:16> = instr<7:4>;           // opc1
        if instr<19:16> == '1111' then     // Rt2==15
            iss<14:10> = bits(5) UNKNOWN;
        else
            iss<14:10> = LookUpRIndex(UInt(instr<19:16>), PSTATE.M)<4:0>;

        if instr<15:12> == '1111' then     // Rt==15
            iss<9:5> = bits(5) UNKNOWN;
        else
            iss<9:5> = LookUpRIndex(UInt(instr<15:12>), PSTATE.M)<4:0>;
        iss<4:1>   = instr<3:0>;           // CRm
    elsif exception.exceptype == Exception_CP14DTTrap then
        // Trapped LDC/STC
        iss<19:12> = instr<7:0>;           // imm8
        iss<4>     = instr<23>;            // U
        iss<2:1>   = instr<24,21>;         // P,W
        if instr<19:16> == '1111' then     // Rn==15, LDC(Literal addressing)/STC
            iss<9:5> = bits(5) UNKNOWN;
            iss<3>   = '1';
    elsif exception.exceptype == Exception_Uncategorized then
        // Trapped for unknown reason
        iss<9:5> = LookUpRIndex(UInt(instr<19:16>), PSTATE.M)<4:0>; // Rn
        iss<3>   = '0';

    iss<0> = instr<20>;                    // Direction

    exception.syndrome<24:20> = ConditionSyndrome();
    exception.syndrome<19:0>  = iss;
```

```
    return exception;
```

Library pseudocode for aarch64/exceptions/traps/AArch64.AdvSIMDFPAccessTrap

```
// AArch64.AdvSIMDFPAccessTrap()
// ============================
// Trapped access to Advanced SIMD or FP registers due to CPACR[].

AArch64.AdvSIMDFPAccessTrap(bits(2) target_el)
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    route_to_el2 = (target_el == EL1 && EL2Enabled() && HCR_EL2.TGE == '1');

    if route_to_el2 then
        exception = ExceptionSyndrome(Exception_Uncategorized);
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        exception = ExceptionSyndrome(Exception_AdvSIMDFPAccessTrap);
        exception.syndrome<24:20> = ConditionSyndrome();
        AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);

    return;
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckCP15InstrCoarseTraps

```
// AArch64.CheckCP15InstrCoarseTraps()
// ===================================
// Check for coarse-grained AArch32 CP15 traps in HSTR_EL2 and HCR_EL2.

boolean AArch64.CheckCP15InstrCoarseTraps(integer CRn, integer nreg, integer CRm)

    // Check for coarse-grained Hyp traps
    if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then
        // Check for MCR, MRC, MCRR and MRRC disabled by HSTR_EL2<CRn/CRm>
        major = if nreg == 1 then CRn else CRm;
        if !IsInHost() && !(major IN {4,14}) && HSTR_EL2<major> == '1' then
            return TRUE;

        // Check for MRC and MCR disabled by HCR_EL2.TIDCP
        if (HCR_EL2.TIDCP == '1' && nreg == 1 &&
            ((CRn == 9  && CRm IN {0,1,2,    5,6,7,8   }) ||
             (CRn == 10 && CRm IN {0,1,    4,      8   }) ||
             (CRn == 11 && CRm IN {0,1,2,3,4,5,6,7,8,15}))) then
            return TRUE;

    return FALSE;
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckFPAdvSIMDEnabled

```
// AArch64.CheckFPAdvSIMDEnabled()
// ===============================
// Check against CPACR[]

AArch64.CheckFPAdvSIMDEnabled()
    if PSTATE.EL IN {EL0, EL1} && !IsInHost() then
        // Check if access disabled in CPACR_EL1
        case CPACR[].FPEN of
            when 'x0'  disabled = TRUE;
            when '01'  disabled = PSTATE.EL == EL0;
            when '11'  disabled = FALSE;
        if disabled then AArch64.AdvSIMDFPAccessTrap(EL1);

    AArch64.CheckFPAdvSIMDTrap();               // Also check against CPTR_EL2 and CPTR_EL3
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckFPAdvSIMDTrap

```
// AArch64.CheckFPAdvSIMDTrap()
// ============================
// Check against CPTR_EL2 and CPTR_EL3.

AArch64.CheckFPAdvSIMDTrap()

    if PSTATE.EL IN {EL0, EL1, EL2} && EL2Enabled() then
        // Check if access disabled in CPTR_EL2
        if HaveVirtHostExt() && HCR_EL2.E2H == '1' then
            case CPTR_EL2.FPEN of
                when 'x0'  disabled = !(PSTATE.EL == EL1 && HCR_EL2.TGE == '1');
                when '01'  disabled = (PSTATE.EL == EL0 && HCR_EL2.TGE == '1');
                when '11'  disabled = FALSE;
            if disabled then AArch64.AdvSIMDFPAccessTrap(EL2);
        else
            if CPTR_EL2.TFP == '1' then AArch64.AdvSIMDFPAccessTrap(EL2);

    if HaveEL(EL3) then
        // Check if access disabled in CPTR_EL3
        if CPTR_EL3.TFP == '1' then AArch64.AdvSIMDFPAccessTrap(EL3);

    return;
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckForERetTrap

```
// AArch64.CheckForERetTrap()
// ==========================
// Check for trap on ERET, ERETAA, ERETAB instruction

AArch64.CheckForERetTrap(boolean eret_with_pac, boolean pac_uses_key_a)

    // Non-secure EL1 execution of ERET, ERETAA, ERETAB when HCR_EL2.NV bit is set, is trapped to EL2
    route_to_el2 = HaveNVExt() && PSTATE.EL == EL1 && EL2Enabled() && HCR_EL2.NV == '1';

    if route_to_el2 then
        ExceptionRecord exception;
        bits(64) preferred_exception_return = ThisInstrAddr();
        vect_offset = 0x0;
        exception = ExceptionSyndrome(Exception_ERetTrap);
        if !eret_with_pac then                              // ERET
            exception.syndrome<1> = '0';
            exception.syndrome<0> = '0';                    // RES0
        else
            exception.syndrome<1> = '1';
            if pac_uses_key_a then                          // ERETAA
                exception.syndrome<0> = '0';
            else    // ERETAB
                exception.syndrome<0> = '1';
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckForSMCUndefOrTrap

```
// AArch64.CheckForSMCUndefOrTrap()
// ================================
// Check for UNDEFINED or trap on SMC instruction

AArch64.CheckForSMCUndefOrTrap(bits(16) imm)
    route_to_el2 = PSTATE.EL == EL1 && EL2Enabled() && HCR_EL2.TSC == '1';
    if PSTATE.EL == EL0 then UNDEFINED;
    if !HaveEL(EL3) then
        if PSTATE.EL == EL1 && EL2Enabled() then
            if HaveNVExt() && HCR_EL2.NV == '1' && HCR_EL2.TSC == '1' then
                route_to_el2 = TRUE;
            else
                UNDEFINED;
        else
            UNDEFINED;
    else
        route_to_el2 = PSTATE.EL == EL1 && EL2Enabled() && HCR_EL2.TSC == '1';
    if route_to_el2 then
        bits(64) preferred_exception_return = ThisInstrAddr();
        vect_offset = 0x0;
        exception = ExceptionSyndrome(Exception_MonitorCall);
        exception.syndrome<15:0> = imm;
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckForWFxTrap

```
// AArch64.CheckForWFxTrap()
// =========================
// Check for trap on WFE or WFI instruction

AArch64.CheckForWFxTrap(bits(2) target_el, boolean is_wfe)
    assert HaveEL(target_el);

    case target_el of
        when EL1 trap = (if is_wfe then SCTLR[].nTWE else SCTLR[].nTWI) == '0';
        when EL2 trap = (if is_wfe then HCR_EL2.TWE else HCR_EL2.TWI) == '1';
        when EL3 trap = (if is_wfe then SCR_EL3.TWE else SCR_EL3.TWI) == '1';
    if trap then
        AArch64.WFxTrap(target_el, is_wfe);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.CheckIllegalState

```
// AArch64.CheckIllegalState()
// ===========================
// Check PSTATE.IL bit and generate Illegal Execution state exception if set.

AArch64.CheckIllegalState()
    if PSTATE.IL == '1' then
        route_to_el2 = PSTATE.EL == EL0 && EL2Enabled() && HCR_EL2.TGE == '1';

        bits(64) preferred_exception_return = ThisInstrAddr();
        vect_offset = 0x0;

        exception = ExceptionSyndrome(Exception_IllegalState);

        if UInt(PSTATE.EL) > UInt(EL1) then
            AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
        elsif route_to_el2 then
            AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
        else
            AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.MonitorModeTrap

```
// AArch64.MonitorModeTrap()
// =========================
// Trapped use of Monitor mode features in a Secure EL1 AArch32 mode

AArch64.MonitorModeTrap()
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_Uncategorized);

    if IsSecureEL2Enabled() then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    AArch64.TakeException(EL3, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.SystemAccessTrap

```
// AArch64.SystemAccessTrap()
// ==========================
// Trapped access to AArch64 system register or system instruction.

AArch64.SystemAccessTrap(bits(2) target_el, integer ec)
    assert HaveEL(target_el) && target_el != EL0 && UInt(target_el) >= UInt(PSTATE.EL);

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = AArch64.SystemAccessTrapSyndrome(ThisInstr(), ec);
    AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.SystemAccessTrapSyndrome

```
// AArch64.SystemAccessTrapSyndrome()
// ==================================
// Returns the syndrome information for traps on AArch64 MSR/MRS instructions.

ExceptionRecord AArch64.SystemAccessTrapSyndrome(bits(32) instr, integer ec)
    ExceptionRecord exception;
    case ec of
        when 0x0                                                    // Trapped access due to unknown rea
            exception = ExceptionSyndrome(Exception_Uncategorized);
        when 0x7                                                    // Trapped access to SVE, Advance SI
            exception = ExceptionSyndrome(Exception_AdvSIMDFPAccessTrap);
            exception.syndrome<24:20> = ConditionSyndrome();
        when 0x18                                                   // Trapped access to system register
            exception = ExceptionSyndrome(Exception_SystemRegisterTrap);
            instr = ThisInstr();
            exception.syndrome<21:20> = instr<20:19>;          // Op0
            exception.syndrome<19:17> = instr<7:5>;            // Op2
            exception.syndrome<16:14> = instr<18:16>;          // Op1
            exception.syndrome<13:10> = instr<15:12>;          // CRn
            exception.syndrome<9:5>   = instr<4:0>;            // Rt
            exception.syndrome<4:1>   = instr<11:8>;           // CRm
            exception.syndrome<0>     = instr<21>;             // Direction
        otherwise
            Unreachable();

    return exception;
```

Library pseudocode for aarch64/exceptions/traps/AArch64.UndefinedFault

```
// AArch64.UndefinedFault()
// ========================

AArch64.UndefinedFault()

    route_to_el2 = PSTATE.EL == EL0 && EL2Enabled() && HCR_EL2.TGE == '1';
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_Uncategorized);

    if UInt(PSTATE.EL) > UInt(EL1) then
        AArch64.TakeException(PSTATE.EL, exception, preferred_exception_return, vect_offset);
    elsif route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(EL1, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/AArch64.WFxTrap

```
// AArch64.WFxTrap()
// =================

AArch64.WFxTrap(bits(2) target_el, boolean is_wfe)
    assert UInt(target_el) > UInt(PSTATE.EL);

    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_WFxTrap);
    exception.syndrome<24:20> = ConditionSyndrome();
    exception.syndrome<0> = if is_wfe then '1' else '0';

    if target_el == EL1 && EL2Enabled() && HCR_EL2.TGE == '1' then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/exceptions/traps/CheckFPAdvSIMDEnabled64

```
// CheckFPAdvSIMDEnabled64()
// =========================
// AArch64 instruction wrapper

CheckFPAdvSIMDEnabled64()
    AArch64.CheckFPAdvSIMDEnabled();
```

Library pseudocode for aarch64/functions/aborts/AArch64.CreateFaultRecord

```
// AArch64.CreateFaultRecord()
// ===========================

FaultRecord AArch64.CreateFaultRecord(Fault statuscode, bits(52) ipaddress, boolean NS,
                                      integer level, AccType acctype, boolean write, bit extflag,
                                      bits(2) errortype, boolean secondstage, boolean s2fs1walk)

    FaultRecord fault;
    fault.statuscode = statuscode;
    fault.domain = bits(4) UNKNOWN;         // Not used from AArch64
    fault.debugmoe = bits(4) UNKNOWN;       // Not used from AArch64
    fault.errortype = errortype;
    fault.ipaddress.NS = if NS then '1' else '0';
    fault.ipaddress.address = ipaddress;
    fault.level = level;
    fault.acctype = acctype;
    fault.write = write;
    fault.extflag = extflag;
    fault.secondstage = secondstage;
    fault.s2fs1walk = s2fs1walk;

    return fault;
```

Library pseudocode for aarch64/functions/aborts/AArch64.FaultSyndrome

```
// AArch64.FaultSyndrome()
// =======================
// Creates an exception syndrome value for Abort and Watchpoint exceptions taken to
// an Exception Level using AArch64.

bits(25) AArch64.FaultSyndrome(boolean d_side, FaultRecord fault)
    assert fault.statuscode != Fault_None;

    bits(25) iss = Zeros();
    if HaveRASExt() && IsExternalSyncAbort(fault) then iss<12:11> = fault.errortype; // SET
    if d_side then
        if IsSecondStage(fault) && !fault.s2fs1walk then iss<24:14> = LSInstructionSyndrome();
        if HaveNV2Ext() && fault.acctype == AccType_NV2REGISTER then
            iss<13> = '1';   // Value of '1' indicates fault is generated by use of VNCR_EL2
        if fault.acctype IN {AccType_DC, AccType_DC_UNPRIV, AccType_IC, AccType_AT} then
            iss<8> = '1';  iss<6> = '1';
        else
            iss<6> = if fault.write then '1' else '0';
    if IsExternalAbort(fault) then iss<9> = fault.extflag;
    iss<7> = if fault.s2fs1walk then '1' else '0';
    iss<5:0> = EncodeLDFSC(fault.statuscode, fault.level);

    return iss;
```

Library pseudocode for aarch64/functions/exclusive/AArch64.ExclusiveMonitorsPass

```
// AArch64.ExclusiveMonitorsPass()
// ===============================

// Return TRUE if the Exclusives monitors for the current PE include all of the addresses
// associated with the virtual address region of size bytes starting at address.
// The immediately following memory write must be to the same addresses.

boolean AArch64.ExclusiveMonitorsPass(bits(64) address, integer size)

    // It is IMPLEMENTATION DEFINED whether the detection of memory aborts happens
    // before or after the check on the local Exclusives monitor. As a result a failure
    // of the local monitor can occur on some implementations even if the memory
    // access would give an memory abort.

    acctype = AccType_ATOMIC;
    iswrite = TRUE;

    aligned = aligned = (address == (address, size));

    if !aligned then
        secondstage = FALSE;
        AArch64.Abort(address, AArch64.AlignmentFaultAArch64.CheckAlignmentAlign(address, size, acctype,
(acctype, iswrite, secondstage));

    passed = AArch64.IsExclusiveVA(address, ProcessorID(), size);
    if !passed then
        return FALSE;
    memaddrdesc = AArch64.TranslateAddress(address, acctype, iswrite, aligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch64.Abort(address, memaddrdesc.fault);

    passed = IsExclusiveLocal(memaddrdesc.paddress, ProcessorID(), size);(), size);

    if passed then
    ClearExclusiveLocal(ProcessorID());

    if passed then
        if memaddrdesc.memattrs.shareable then
            passed = IsExclusiveGlobal(memaddrdesc.paddress, ProcessorID(), size);

    return passed;
```

Library pseudocode for aarch64/functions/exclusive/AArch64.IsExclusiveVA

```
// An optional IMPLEMENTATION DEFINED test for an exclusive access to a virtual
// address region of size bytes starting at address.
//
// It is permitted (but not required) for this function to return FALSE and
// cause a store exclusive to fail if the virtual address region is not
// totally included within the region recorded by MarkExclusiveVA().
//
// It is always safe to return TRUE which will check the physical address only.
boolean AArch64.IsExclusiveVA(bits(64) address, integer processorid, integer size);
```

Library pseudocode for aarch64/functions/exclusive/AArch64.MarkExclusiveVA

```
// Optionally record an exclusive access to the virtual address region of size bytes
// starting at address for processorid.
AArch64.MarkExclusiveVA(bits(64) address, integer processorid, integer size);
```

Library pseudocode for aarch64/functions/exclusive/AArch64.SetExclusiveMonitors

```
// AArch64.SetExclusiveMonitors()
// ==============================

// Sets the Exclusives monitors for the current PE to record the addresses associated
// with the virtual address region of size bytes starting at address.

AArch64.SetExclusiveMonitors(bits(64) address, integer size)

    acctype = AccType_ATOMIC;
    iswrite = FALSE;
    aligned = (address == Align(address, size));
    memaddrdesc = AArch64.TranslateAddress(address, acctype, iswrite, aligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        return;

    if memaddrdesc.memattrs.shareable then
        MarkExclusiveGlobal(memaddrdesc.paddress, ProcessorID(), size);

    MarkExclusiveLocal(memaddrdesc.paddress, ProcessorID(), size);

    AArch64.MarkExclusiveVA(address, ProcessorID(), size);
```

Library pseudocode for aarch64/functions/fusedrstep/FPRSqrtStepFused

```
// FPRSqrtStepFused()
// ==================

bits(N) FPRSqrtStepFused(bits(N) op1, bits(N) op2)
    assert N IN {16, 32, 64};
    bits(N) result;
    op1 = FPNeg(op1);
    (type1,sign1,value1) = FPUnpack(op1, FPCR);
    (type2,sign2,value2) = FPUnpack(op2, FPCR);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, FPCR);
    if !done then
        inf1 = (type1 == FPType_Infinity);
        inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);
        zero2 = (type2 == FPType_Zero);
        if (inf1 && zero2) || (zero1 && inf2) then
            result = FPOnePointFive('0');
        elsif inf1 || inf2 then
            result = FPInfinity(sign1 EOR sign2);
        else
            // Fully fused multiply-add and halve
            result_value = (3.0 + (value1 * value2)) / 2.0;
            if result_value == 0.0 then
                // Sign of exact zero result depends on rounding mode
                sign = if FPRoundingMode(FPCR) == FPRounding_NEGINF then '1' else '0';
                result = FPZero(sign);
            else
                result = FPRound(result_value, FPCR);
    return result;
```

Library pseudocode for aarch64/functions/fusedrstep/FPRecipStepFused

```
// FPRecipStepFused()
// ==================

bits(N) FPRecipStepFused(bits(N) op1, bits(N) op2)
    assert N IN {16, 32, 64};
    bits(N) result;
    op1 = FPNeg(op1);
    (type1,sign1,value1) = FPUnpack(op1, FPCR);
    (type2,sign2,value2) = FPUnpack(op2, FPCR);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, FPCR);
    if !done then
        inf1 = (type1 == FPType_Infinity);
        inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);
        zero2 = (type2 == FPType_Zero);
        if (inf1 && zero2) || (zero1 && inf2) then
            result = FPTwo('0');
        elsif inf1 || inf2 then
            result = FPInfinity(sign1 EOR sign2);
        else
            // Fully fused multiply-add
            result_value = 2.0 + (value1 * value2);
            if result_value == 0.0 then
                // Sign of exact zero result depends on rounding mode
                sign = if FPRoundingMode(FPCR) == FPRounding_NEGINF then '1' else '0';
                result = FPZero(sign);
            else
                result = FPRound(result_value, FPCR);
    return result;
```

Library pseudocode for aarch64/functions/memory/AArch64.AccessIsTagChecked

```
// AArch64.AccessIsTagChecked()
// ============================
// TRUE if a given access is tag-checked, FALSE otherwise.

boolean AArch64.AccessIsTagChecked(bits(64) vaddr, AccType acctype)
    if PSTATE.M<4> == '1' then return FALSE;

    if EffectiveTBI(vaddr, FALSE, PSTATE.EL) == '0' then
        return FALSE;

    if EffectiveTCMA(vaddr, PSTATE.EL) == '1' && (vaddr<59:55> == '00000' || vaddr<59:55> == '11111') the
        return FALSE;

    if !AArch64.AllocationTagAccessIsEnabled() then
        return FALSE;

    if acctype IN {AccType_IFETCH, AccType_PTW} then
        return FALSE;

    if acctype == AccType_NV2REGISTER then
        return FALSE;

    if PSTATE.TCO=='1' then
        return FALSE;

    if IsNonTagCheckedInstruction() then
        return FALSE;

    return TRUE;
```

Library pseudocode for aarch64/functions/memory/AArch64.AddressWithAllocationTag

```
// AArch64.AddressWithAllocationTag()
// ==================================
// Generate a 64-bit value containing a Logical Address Tag from a 64-bit
// virtual address and an Allocation Tag.
// If the extension is disabled, treats the Allocation Tag as '0000'.

bits(64) AArch64.AddressWithAllocationTag(bits(64) address, bits(4) allocation_tag)
    bits(64) result = address;
    bits(4) tag;
    if     bits(4) tag = allocation_tag - ('000':address<55>);
    result<59:56> = tag;
    return result; AArch64.AllocationTagAccessIsEnabled() then
        tag = allocation_tag;
    else
        tag = '0000';
    result<59:56> = tag;
    return result;
```

Library pseudocode for aarch64/functions/memory/AArch64.AllocationTagFromAddress

```
// AArch64.AllocationTagFromAddress()
// ==================================
// Generate an ALlocation Tag from a 64-bit value containing a Logical Address Tag.
// Generate a Tag from a 64-bit value containing a Logical Address Tag.
// If access to Allocation Tags is disabled, this function returns '0000'.

bits(4) AArch64.AllocationTagFromAddress(bits(64) tagged_address)
    return tagged_address<59:56>;    bits(4) logical_tag = tagged_address<59:56>;
    bits(4) tag = logical_tag + ('000':tagged_address<55>);
    return tag;
```

Library pseudocode for aarch64/functions/memory/AArch64.CheckAlignment

```
// AArch64.CheckAlignment()
// ========================

boolean AArch64.CheckAlignment(bits(64) address, integer alignment, AccType acctype,
                               boolean iswrite)

    aligned = (address == Align(address, alignment));
    atomic  = acctype IN { AccType_ATOMIC, AccType_ATOMICRW, AccType_ORDEREDATOMIC, AccType_ORDEREDATOMIC
    ordered = acctype IN { AccType_ORDERED, AccType_ORDEREDRW, AccType_LIMITEDORDERED, AccType_ORDEREDATO
    vector  = acctype == AccType_VEC;
    if SCTLR[].A == '1' then check = TRUE;
    elsif HaveUA16Ext() then
        check = (UInt(address<0+:4>) + alignment > 16) && ((ordered && SCTLR[].nAA == '0') || atomic);
    else check = atomic || ordered;

    if check && !aligned then
        secondstage = FALSE;
        AArch64.Abort(address, AArch64.AlignmentFault(acctype, iswrite, secondstage));

    return aligned;
```

Library pseudocode for aarch64/functions/memory/AArch64.CheckTag

```
// AArch64.CheckTag()
// ==================
// Performs a Tag Check operation for a memory access and returns
// whether the check passed

boolean AArch64.CheckTag(AddressDescriptor memaddrdesc, bits(4) ptag, boolean write)
    if memaddrdesc.memattrs.tagged then
        return ptag == _MemTag[memaddrdesc];
    else
        return TRUE;
```

Library pseudocode for aarch64/functions/memory/AArch64.MemSingle

```
// AArch64.MemSingle[] - non-assignment (read) form
// ================================================
// Perform an atomic, little-endian read of 'size' bytes.

bits(size*8) AArch64.MemSingle[bits(64) address, integer size, AccType acctype, boolean wasaligned]
    assert size IN {1, 2, 4, 8, 16};
    assert address == Align(address, size);

    AddressDescriptor memaddrdesc;
    bits(size*8) value;
    iswrite = FALSE;

    // MMU or MPU
    memaddrdesc = AArch64.TranslateAddress(address, acctype, iswrite, wasaligned, size);
    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch64.Abort(address, memaddrdesc.fault);

    // Memory array access
    transactional = TSTATE.depth > 0 && !(acctype IN {AccType_IFETCH,AccType_PTW});
    accdesc =     accdesc = CreateAccessDescriptor(acctype, transactional);
    if CreateAccessDescriptor(acctype, transactional);
    if HaveMTEExt() then
        if AArch64.AccessIsTagChecked(ZeroExtend(address, 64), acctype) then
            bits(4) ptag = AArch64.PhysicalTagAArch64.TransformTag(ZeroExtend(address, 64));
            if !AArch64.CheckTag(memaddrdesc, ptag, iswrite) then
                AArch64.TagCheckFail(ZeroExtend(address, 64), iswrite);
    value = _Mem[memaddrdesc, size, accdesc];
    return value;

// AArch64.MemSingle[] - assignment (write) form
// =============================================
// Perform an atomic, little-endian write of 'size' bytes.

AArch64.MemSingle[bits(64) address, integer size, AccType acctype, boolean wasaligned] = bits(size*8) val
    assert size IN {1, 2, 4, 8, 16};
    assert address == Align(address, size);

    AddressDescriptor memaddrdesc;
    iswrite = TRUE;

    // MMU or MPU
    memaddrdesc = AArch64.TranslateAddress(address, acctype, iswrite, wasaligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch64.Abort(address, memaddrdesc.fault);

    // Effect on exclusives
    if memaddrdesc.memattrs.shareable then
        ClearExclusiveByAddress(memaddrdesc.paddress, ProcessorID(), size);

    // Memory array access
    transactional = TSTATE.depth > 0;
    accdesc =     accdesc = CreateAccessDescriptor(acctype, transactional);
    if CreateAccessDescriptor(acctype, transactional);
    if HaveMTEExt() then
        if AArch64.AccessIsTagChecked(ZeroExtend(address, 64), acctype) then
            bits(4) ptag = AArch64.PhysicalTagAArch64.TransformTag(ZeroExtend(address, 64));
            if !AArch64.CheckTag(memaddrdesc, ptag, iswrite) then
                AArch64.TagCheckFail(ZeroExtend(address, 64), iswrite);
    _Mem[memaddrdesc, size, accdesc] = value;
    return;
```

Library pseudocode for aarch64/functions/memory/AArch64.MemTag

```
// AArch64.MemTag[] - non-assignment (read) form
// =============================================
// Load an Allocation Tag from memory.

bits(4) AArch64.MemTag[bits(64) address]
    AddressDescriptor memaddrdesc;
    bits(4) value;
    iswrite = FALSE;

    memaddrdesc = AArch64.TranslateAddress(address, AccType_NORMAL, iswrite, TRUE, TAG_GRANULE);
    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch64.Abort(address, memaddrdesc.fault);

    // Return the granule tag if tagging is enabled...
    if AArch64.AllocationTagAccessIsEnabled() && memaddrdesc.memattrs.tagged then
        return _MemTag[memaddrdesc];
    else
        // ...otherwise read tag as zero.
        return '0000';

// AArch64.MemTag[] - assignment (write) form
// ==========================================
// Store an Allocation Tag to memory.

AArch64.MemTag[bits(64) address] = bits(4) value
    AddressDescriptor memaddrdesc;
    iswrite = TRUE;

    // Stores of allocation tags must be aligned
    if address != Align(address, TAG_GRANULE) then
        boolean secondstage = FALSE;
        AArch64.Abort(address, AArch64.AlignmentFault(AccType_NORMAL, iswrite, secondstage));

    wasaligned = TRUE;
    memaddrdesc = AArch64.TranslateAddress(address, AccType_NORMAL, iswrite, wasaligned, TAG_GRANULE);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch64.Abort(address, memaddrdesc.fault);

    // Memory array access
    if AArch64.AllocationTagAccessIsEnabled() && memaddrdesc.memattrs.tagged then
        _MemTag[memaddrdesc] = value;
```

Library pseudocode for aarch64/functions/memory/AArch64.PhysicalTag~~AArch64.TransformTag~~

```
// AArch64.PhysicalTag()
// =====================
// Generate a Physical Tag from a Logical Tag in an address
// AArch64.TransformTag()
// ======================
// Apply tag transformation rules.

bits(4) AArch64.PhysicalTag(bits(64) vaddr)
    return vaddr<59:56>;AArch64.TransformTag(bits(64) vaddr)
    bits(4) vtag = vaddr<59:56>;
    bits(4) tagdelta =ZeroExtend(vaddr<55>);
    bits(4) ptag = vtag + tagdelta;
    return ptag;
```

Library pseudocode for aarch64/functions/memory/AArch64.TranslateAddressForAtomicAccess

```
// AArch64.TranslateAddressForAtomicAccess()
// =========================================
// Performs an alignment check for atomic memory operations.
// Also translates 64-bit Virtual Address into Physical Address.

AddressDescriptor AArch64.TranslateAddressForAtomicAccess(bits(64) address, integer sizeinbits)
    boolean iswrite = FALSE;
    size = sizeinbits DIV 8;

    assert size IN {1, 2, 4, 8, 16};

    aligned = AArch64.CheckAlignment(address, size, AccType_ATOMICRW, iswrite);

    // MMU or MPU lookup
    memaddrdesc = AArch64.TranslateAddress(address, AccType_ATOMICRW, iswrite, aligned, size);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        AArch64.Abort(address, memaddrdesc.fault);

    // Effect on exclusives
    if memaddrdesc.memattrs.shareable then
        ClearExclusiveByAddress(memaddrdesc.paddress, ProcessorID(), size);

    if HaveMTEExt() && AArch64.AccessIsTagChecked(address, AccType_ATOMICRW) then
        bits(4) ptag = AArch64.PhysicalTagAArch64.TransformTag(address);
        if !AArch64.CheckTag(memaddrdesc, ptag, iswrite) then
            AArch64.TagCheckFail(address, iswrite);

    return memaddrdesc;
```

Library pseudocode for aarch64/functions/memory/CheckSPAlignment

```
// CheckSPAlignment()
// ==================
// Check correct stack pointer alignment for AArch64 state.

CheckSPAlignment()
    bits(64) sp = SP[];
    if PSTATE.EL == EL0 then
        stack_align_check = (SCTLR[].SA0 != '0');
    else
        stack_align_check = (SCTLR[].SA != '0');

    if stack_align_check && sp != Align(sp, 16) then
        AArch64.SPAlignmentFault();

    return;
```

Library pseudocode for aarch64/functions/memory/IsBlockDescriptorNTBitValid

```
// If the implementation supports changing the block size without a break-before-make
// approach, then for implementations that have level 1 or 2 support, the nT bit in
// the block descriptor is valid.
boolean IsBlockDescriptorNTBitValid();
```

Library pseudocode for aarch64/functions/memory/Mem

```
// Mem[] - non-assignment (read) form
// ==================================
// Perform a read of 'size' bytes. The access byte order is reversed for a big-endian access.
// Instruction fetches would call AArch64.MemSingle directly.

bits(size*8) Mem[bits(64) address, integer size, AccType acctype]
    assert size IN {1, 2, 4, 8, 16};
    bits(size*8) value;
    boolean iswrite = FALSE;

    aligned = AArch64.CheckAlignment(address, size, acctype, iswrite);
    if size != 16 || !(acctype IN {AccType_VEC, AccType_VECSTREAM}) then
        atomic = aligned;
    else
        // 128-bit SIMD&FP loads are treated as a pair of 64-bit single-copy atomic accesses
        // 64-bit aligned.
        atomic = address == Align(address, 8);

    if !atomic then
        assert size > 1;
        value<7:0> = AArch64.MemSingle[address, 1, acctype, aligned];

        // For subsequent bytes it is CONSTRAINED UNPREDICTABLE whether an unaligned Device memory
        // access will generate an Alignment Fault, as to get this far means the first byte did
        // not, so we must be changing to a new translation page.
        if !aligned then
            c = ConstrainUnpredictable(Unpredictable_DEVPAGE2);
            assert c IN {Constraint_FAULT, Constraint_NONE};
            if c == Constraint_NONE then aligned = TRUE;

        for i = 1 to size-1
            value<8*i+7:8*i> = AArch64.MemSingle[address+i, 1, acctype, aligned];
    elsif size == 16 && acctype IN {AccType_VEC, AccType_VECSTREAM} then
        value<63:0>   = AArch64.MemSingle[address,   8, acctype, aligned];
        value<127:64> = AArch64.MemSingle[address+8, 8, acctype, aligned];
    else
        value = AArch64.MemSingle[address, size, acctype, aligned];

    if (HaveNV2Ext() && acctype == AccType_NV2REGISTER && SCTLR_EL2.EE == '1') || BigEndian() then
        value = BigEndianReverse(value);
    return value;

// Mem[] - assignment (write) form
// ===============================
// Perform a write of 'size' bytes. The byte order is reversed for a big-endian access.

Mem[bits(64) address, integer size, AccType acctype] = bits(size*8) value
    boolean iswrite = TRUE;

    if (HaveNV2Ext() && acctype == AccType_NV2REGISTER && SCTLR_EL2.EE == '1') || BigEndian() then
        value = BigEndianReverse(value);

    aligned = AArch64.CheckAlignment(address, size, acctype, iswrite);
    if size != 16 || !(acctype IN {AccType_VEC, AccType_VECSTREAM}) then
        atomic = aligned;
    else
        // 128-bit SIMD&FP stores are treated as a pair of 64-bit single-copy atomic accesses
        // 64-bit aligned.
        atomic = address == Align(address, 8);

    if !atomic then
        assert size > 1;
        AArch64.MemSingle[address, 1, acctype, aligned] = value<7:0>;

        // For subsequent bytes it is CONSTRAINED UNPREDICTABLE whether an unaligned Device memory
        // access will generate an Alignment Fault, as to get this far means the first byte did
        // not, so we must be changing to a new translation page.
        if !aligned then
            c = ConstrainUnpredictable(Unpredictable_DEVPAGE2);
            assert c IN {Constraint_FAULT, Constraint_NONE};
```

```
            if c == Constraint_NONE then aligned = TRUE;

        for i = 1 to size-1
            AArch64.MemSingle[address+i, 1, acctype, aligned] = value<8*i+7:8*i>;
    elsif size == 16 && acctype IN {AccType_VEC, AccType_VECSTREAM} then
        AArch64.MemSingle[address,   8, acctype, aligned] = value<63:0>;
        AArch64.MemSingle[address+8, 8, acctype, aligned] = value<127:64>;
    else
        AArch64.MemSingle[address, size, acctype, aligned] = value;
    return;
```

Library pseudocode for aarch64/functions/memory/MemAtomic

```
// MemAtomic()
// ===========
// Performs load and store memory operations for a given virtual address.
// Performs a load and store memory operation for a given virtual address.

bits(size) MemAtomic(bits(64) address, MemAtomicOp op, bits(size) value, AccType ldacctype, AccType stacc
    bits(size) newvalue;
    memaddrdesc = AArch64.TranslateAddressForAtomicAccess(address, size);
    ldaccdesc =     ldaccdesc = CreateAccessDescriptor(ldacctype);
    staccdesc = CreateAccessDescriptor(stacctype);

    // All observers in the shareability domain observe the
    // following load and store atomically.
    oldvalue = _Mem[memaddrdesc, size DIV 8, ldaccdesc];
    if CreateAccessDescriptor(ldacctype);
    staccdesc = CreateAccessDescriptor(stacctype);

    // All observers in the shareability domain observe the
    // following load and store atomically.
    oldvalue = _Mem[memaddrdesc, size DIV 8, ldaccdesc];
    if BigEndian() then
        oldvalue = BigEndianReverse(oldvalue);

    case op of
        when MemAtomicOp_ADD   newvalue = oldvalue + value;
        when MemAtomicOp_BIC   newvalue = oldvalue AND NOT(value);
        when MemAtomicOp_EOR   newvalue = oldvalue EOR value;
        when MemAtomicOp_ORR   newvalue = oldvalue OR value;
        when MemAtomicOp_SMAX  newvalue = if SInt(oldvalue) > SInt(value) then oldvalue else value;
        when MemAtomicOp_SMIN  newvalue = if SInt(oldvalue) > SInt(value) then value else oldvalue;
        when MemAtomicOp_UMAX  newvalue = if UInt(oldvalue) > UInt(value) then oldvalue else value;
        when MemAtomicOp_UMIN  newvalue = if UInt(oldvalue) > UInt(value) then value else oldvalue;
        when MemAtomicOp_SWP   newvalue = value;

    if BigEndian() then
        newvalue = BigEndianReverse(newvalue);
    _Mem[memaddrdesc, size DIV 8, staccdesc] = newvalue;

    // Load operations return the old (pre-operation) value
    return oldvalue;
```

Library pseudocode for aarch64/functions/memory/MemAtomicCompareAndSwap

```
// MemAtomicCompareAndSwap()
// =========================
// Compares the value stored at the passed-in memory address against the passed-in expected
// value. If the comparison is successful, the value at the passed-in memory address is swapped
// with the passed-in new_value.

bits(size) MemAtomicCompareAndSwap(bits(64) address, bits(size) expectedvalue,
                                   bits(size) newvalue, AccType ldacctype, AccType stacctype)
    memaddrdesc = AArch64.TranslateAddressForAtomicAccess(address, size);
    ldaccdesc = CreateAccessDescriptor(ldacctype);
    staccdesc = CreateAccessDescriptor(stacctype);

    // All observers in the shareability domain observe the
    // following load and store atomically.
    oldvalue = _Mem[memaddrdesc, size DIV 8, ldaccdesc];
    if BigEndian() then
        oldvalue = BigEndianReverse(oldvalue);

    if oldvalue == expectedvalue then
        if BigEndian() then
            newvalue = BigEndianReverse(newvalue);
        _Mem[memaddrdesc, size DIV 8, staccdesc] = newvalue;
    return oldvalue;
```

Library pseudocode for aarch64/functions/pac/addpac/AddPAC

```
// AddPAC()
// ========
// Calculates the pointer authentication code for a 64-bit quantity and then
// inserts that into pointer authentication code field of that 64-bit quantity.

bits(64) AddPAC(bits(64) ptr, bits(64) modifier, bits(128) K, boolean data)
    bits(64) PAC;
    bits(64) result;
    bits(64) ext_ptr;
    bits(64) extfield;
    bit selbit;
    boolean tbi = CalculateTBI(ptr, data);
    integer top_bit = if tbi then 55 else 63;

    // If tagged pointers are in use for a regime with two TTBRs, use bit<55> of
    // the pointer to select between upper and lower ranges, and preserve this.
    // This handles the awkward case where there is apparently no correct choice between
    // the upper and lower address range - ie an addr of 1xxxxxxx0... with TBI0=0 and TBI1=1
    // and 0xxxxxxx1 with TBI1=0 and TBI0=1:
    if PtrHasUpperAndLowerAddRanges() then
        assert S1TranslationRegime() IN {EL1, EL2};
        if S1TranslationRegime() == EL1 then
            // EL1 translation regime registers
            if data then
                selbit = if TCR_EL1.TBI1 == '1' || TCR_EL1.TBI0 == '1' then ptr<55> else ptr<63>;
            else
                if ((TCR_EL1.TBI1 == '1' && TCR_EL1.TBID1 == '0') ||
                    (TCR_EL1.TBI0 == '1' && TCR_EL1.TBID0 == '0')) then
                    selbit = ptr<55>;
                else
                    selbit = ptr<63>;
        else
            // EL2 translation regime registers
            if data then
                selbit = if ((HaveEL(EL2) && TCR_EL2.TBI1 == '1') ||
                             (HaveEL(EL2) && TCR_EL2.TBI0 == '1')) then ptr<55> else ptr<63>;
            else
                selbit = if ((HaveEL(EL2) && TCR_EL2.TBI1 == '1' && TCR_EL1.TBID1 == '0') ||
                             (HaveEL(EL2) && TCR_EL2.TBI0 == '1' && TCR_EL1.TBID0 == '0')) then ptr<55> e
    else selbit = if tbi then ptr<55> else ptr<63>;

    integer bottom_PAC_bit = CalculateBottomPACBit(selbit);

    // The pointer authentication code field takes all the available bits in between
    extfield = Replicate(selbit, 64);

    // Compute the pointer authentication code for a ptr with good extension bits
    if tbi then
        ext_ptr = ptr<63:56>:extfield<(56-bottom_PAC_bit)-1:0>:ptr<bottom_PAC_bit-1:0>;
    else
        ext_ptr = extfield<(64-bottom_PAC_bit)-1:0>:ptr<bottom_PAC_bit-1:0>;

    PAC = ComputePAC(ext_ptr, modifier, K<127:64>, K<63:0>);

    // Check if the ptr has good extension bits and corrupt the pointer authentication code if not
    if !IsZero(ptr<top_bit:bottom_PAC_bit>) && !IsOnes(ptr<top_bit:bottom_PAC_bit>) then
        if HaveEnhancedPAC() then
            PAC = Zeros();
        else
            PAC<top_bit-1> = NOT(PAC<top_bit-1>);

    // Preserve the determination between upper and lower address at bit<55> and insert PAC
    if tbi then
        result = ptr<63:56>:selbit:PAC<54:bottom_PAC_bit>:ptr<bottom_PAC_bit-1:0>;
    else
        result = PAC<63:56>:selbit:PAC<54:bottom_PAC_bit>:ptr<bottom_PAC_bit-1:0>;
    return result;
```

Library pseudocode for aarch64/functions/pac/addpacda/AddPACDA

```
// AddPACDA()
// ==========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with a pointer authentication code, where the pointer authentication
// code is derived using a cryptographic algorithm as a combination of X, Y and the
// APDAKey_EL1.

bits(64) AddPACDA(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APDAKey_EL1;

    APDAKey_EL1 = APDAKeyHi_EL1<63:0> : APDAKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnDA else SCTLR_EL2.EnDA;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                         (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnDA;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnDA;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnDA;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else return AddPAC(X, Y, APDAKey_EL1, TRUE);
```

Library pseudocode for aarch64/functions/pac/addpacdb/AddPACDB

```
// AddPACDB()
// ==========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with a pointer authentication code, where the pointer authentication
// code is derived using a cryptographic algorithm as a combination of X, Y and the
// APDBKey_EL1.

bits(64) AddPACDB(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APDBKey_EL1;

    APDBKey_EL1 = APDBKeyHi_EL1<63:0> : APDBKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnDB else SCTLR_EL2.EnDB;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnDB;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnDB;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnDB;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else return AddPAC(X, Y, APDBKey_EL1, TRUE);
```

Library pseudocode for aarch64/functions/pac/addpacga/AddPACGA

```
// AddPACGA()
// ==========
// Returns a 64-bit value where the lower 32 bits are 0, and the upper 32 bits contain
// a 32-bit pointer authentication code which is derived using a cryptographic
// algorithm as a combination of X, Y and the APGAKey_EL1.

bits(64) AddPACGA(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(128) APGAKey_EL1;

    APGAKey_EL1 = APGAKeyHi_EL1<63:0> : APGAKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else return ComputePAC(X, Y, APGAKey_EL1<127:64>, APGAKey_EL1<63:0>)<63:32>:Zeros(32);
```

Library pseudocode for aarch64/functions/pac/addpacia/AddPACIA

```
// AddPACIA()
// ==========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with a pointer authentication code, where the pointer authentication
// code is derived using a cryptographic algorithm as a combination of X, Y, and the
// APIAKey_EL1.

bits(64) AddPACIA(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APIAKey_EL1;

    APIAKey_EL1 = APIAKeyHi_EL1<63:0>:APIAKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnIA else SCTLR_EL2.EnIA;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnIA;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnIA;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnIA;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else return AddPAC(X, Y, APIAKey_EL1, FALSE);
```

Library pseudocode for aarch64/functions/pac/addpacib/AddPACIB

```
// AddPACIB()
// ==========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with a pointer authentication code, where the pointer authentication
// code is derived using a cryptographic algorithm as a combination of X, Y and the
// APIBKey_EL1.

bits(64) AddPACIB(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APIBKey_EL1;

    APIBKey_EL1 = APIBKeyHi_EL1<63:0> : APIBKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnIB else SCTLR_EL2.EnIB;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnIB;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnIB;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnIB;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else return AddPAC(X, Y, APIBKey_EL1, FALSE);
```

Library pseudocode for aarch64/functions/pac/auth/Auth

```
// Auth()
// ======
// Restores the upper bits of the address to be all zeros or all ones (based on the
// value of bit[55]) and computes and checks the pointer authentication code. If the
// check passes, then the restored address is returned. If the check fails, the
// second-top and third-top bits of the extension bits in the pointer authentication code
// field are corrupted to ensure that accessing the address will give a translation fault.

bits(64) Auth(bits(64) ptr, bits(64) modifier, bits(128) K, boolean data, bit keynumber)
    bits(64) PAC;
    bits(64) result;
    bits(64) original_ptr;
    bits(2) error_code;
    bits(64) extfield;

    // Reconstruct the extension field used of adding the PAC to the pointer
    boolean tbi = CalculateTBI(ptr, data);
    integer bottom_PAC_bit = CalculateBottomPACBit(ptr<55>);
    extfield = Replicate(ptr<55>, 64);

    if tbi then
        original_ptr = ptr<63:56>:extfield<56-bottom_PAC_bit-1:0>:ptr<bottom_PAC_bit-1:0>;
    else
        original_ptr = extfield<64-bottom_PAC_bit-1:0>:ptr<bottom_PAC_bit-1:0>;

    PAC = ComputePAC(original_ptr, modifier, K<127:64>, K<63:0>);
    // Check pointer authentication code
    if tbi then
        if PAC<54:bottom_PAC_bit> == ptr<54:bottom_PAC_bit> then
            result = original_ptr;
        else
            error_code = keynumber:NOT(keynumber);
            result = original_ptr<63:55>:error_code:original_ptr<52:0>;
    else
        if ((PAC<54:bottom_PAC_bit> == ptr<54:bottom_PAC_bit>) &&
            (PAC<63:56> == ptr<63:56>)) then
            result = original_ptr;
        else
            error_code = keynumber:NOT(keynumber);
            result = original_ptr<63>:error_code:original_ptr<60:0>;
    return result;
```

Library pseudocode for aarch64/functions/pac/authda/AuthDA

```
// AuthDA()
// ========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with the extension of the address bits. The instruction checks a pointer
// authentication code in the pointer authentication code field bits of X, using the same
// algorithm and key as AddPACDA().

bits(64) AuthDA(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APDAKey_EL1;

    APDAKey_EL1 = APDAKeyHi_EL1<63:0> : APDAKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnDA else SCTLR_EL2.EnDA;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnDA;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnDA;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnDA;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else  return Auth(X, Y, APDAKey_EL1, TRUE, '0');
```

Library pseudocode for aarch64/functions/pac/authdb/AuthDB

```
// AuthDB()
// ========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with the extension of the address bits. The instruction checks a
// pointer authentication code in the pointer authentication code field bits of X, using
// the same algorithm and key as AddPACDB().

bits(64) AuthDB(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APDBKey_EL1;

    APDBKey_EL1 = APDBKeyHi_EL1<63:0> : APDBKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnDB else SCTLR_EL2.EnDB;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                         (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnDB;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnDB;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnDB;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else  return Auth(X, Y, APDBKey_EL1, TRUE, '1');
```

Library pseudocode for aarch64/functions/pac/authia/AuthIA

```
// AuthIA()
// ========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with the extension of the address bits. The instruction checks a pointer
// authentication code in the pointer authentication code field bits of X, using the same
// algorithm and key as AddPACIA().

bits(64) AuthIA(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APIAKey_EL1;

    APIAKey_EL1 = APIAKeyHi_EL1<63:0> : APIAKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnIA else SCTLR_EL2.EnIA;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnIA;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnIA;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnIA;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else  return Auth(X, Y, APIAKey_EL1, FALSE, '0');
```

Library pseudocode for aarch64/functions/pac/authib/AuthIB

```
// AuthIB()
// ========
// Returns a 64-bit value containing X, but replacing the pointer authentication code
// field bits with the extension of the address bits. The instruction checks a pointer
// authentication code in the pointer authentication code field bits of X, using the same
// algorithm and key as AddPACIB().

bits(64) AuthIB(bits(64) X, bits(64) Y)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(1)  Enable;
    bits(128) APIBKey_EL1;

    APIBKey_EL1 = APIBKeyHi_EL1<63:0> : APIBKeyLo_EL1<63:0>;

    case PSTATE.EL of
        when EL0
            boolean IsEL1Regime = S1TranslationRegime() == EL1;
            Enable = if IsEL1Regime then SCTLR_EL1.EnIB else SCTLR_EL2.EnIB;
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            Enable = SCTLR_EL1.EnIB;
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            Enable = SCTLR_EL2.EnIB;
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            Enable = SCTLR_EL3.EnIB;
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if Enable == '0' then return X;
    elsif TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else  return Auth(X, Y, APIBKey_EL1, FALSE, '1');
```

Library pseudocode for aarch64/functions/pac/calcbottompacbit/CalculateBottomPACBit

```
// CalculateBottomPACBit()
// =======================

integer CalculateBottomPACBit(bit top_bit)
    integer tsz_field;

    if PtrHasUpperAndLowerAddRanges() then
        assert S1TranslationRegime() IN {EL1, EL2};
        if S1TranslationRegime() == EL1 then
            // EL1 translation regime registers
            tsz_field = if top_bit == '1' then UInt(TCR_EL1.T1SZ) else UInt(TCR_EL1.T0SZ);
            using64k = if top_bit == '1' then TCR_EL1.TG1 == '11' else TCR_EL1.TG0 == '01';
        else
            // EL2 translation regime registers
            assert HaveEL(EL2);
            tsz_field = if top_bit == '1' then UInt(TCR_EL2.T1SZ) else UInt(TCR_EL2.T0SZ);
            using64k = if top_bit == '1' then TCR_EL2.TG1 == '11' else TCR_EL2.TG0 == '01';
    else
        tsz_field = if PSTATE.EL == EL2 then UInt(TCR_EL2.T0SZ) else UInt(TCR_EL3.T0SZ);
        using64k = if PSTATE.EL == EL2 then TCR_EL2.TG0 == '01' else TCR_EL3.TG0 == '01';

    max_limit_tsz_field = (if !HaveSmallPageTblExt() then 39 else if using64k then 47 else 48);
    if tsz_field > max_limit_tsz_field then
        // TCR_ELx.TySZ is out of range
        c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
        assert c IN {Constraint_FORCE, Constraint_NONE};
        if c == Constraint_FORCE then tsz_field = max_limit_tsz_field;
    tszmin = if using64k && VAMax() == 52 then 12 else 16;
    if tsz_field < tszmin then
        c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
        assert c IN {Constraint_FORCE, Constraint_NONE};
        if c == Constraint_FORCE then tsz_field = tszmin;
    return (64-tsz_field);
```

Library pseudocode for aarch64/functions/pac/calculatetbi/CalculateTBI

```
// CalculateTBI()
// ==============

boolean CalculateTBI(bits(64) ptr, boolean data)
    boolean tbi = FALSE;

    if PtrHasUpperAndLowerAddRanges() then
        assert S1TranslationRegime() IN {EL1, EL2};
        if S1TranslationRegime() == EL1 then
            // EL1 translation regime registers
            if data then
                tbi = if ptr<55> == '1' then TCR_EL1.TBI1 == '1' else TCR_EL1.TBI0 == '1';
            else
                if ptr<55> == '1' then
                    tbi = TCR_EL1.TBI1 == '1' && TCR_EL1.TBID1 == '0';
                else
                    tbi = TCR_EL1.TBI0 == '1' && TCR_EL1.TBID0 == '0';
        else
            // EL2 translation regime registers
            if data then
                tbi = if ptr<55> == '1' then TCR_EL2.TBI1 == '1' else TCR_EL2.TBI0 == '1';
            else
                if ptr<55> == '1' then
                    tbi = TCR_EL2.TBI1 == '1' && TCR_EL2.TBID1 == '0';
                else
                    tbi = TCR_EL2.TBI0 == '1' && TCR_EL2.TBID0 == '0';
    elsif PSTATE.EL == EL2 then
        tbi = if data then TCR_EL2.TBI=='1' else TCR_EL2.TBI=='1' && TCR_EL2.TBID=='0';
    elsif PSTATE.EL == EL3 then
        tbi = if data then TCR_EL3.TBI=='1' else TCR_EL3.TBI=='1' && TCR_EL3.TBID=='0';

    return tbi;
```

Library pseudocode for aarch64/functions/pac/computepac/ComputePAC

```
array bits(64) RC[0..4];

bits(64) ComputePAC(bits(64) data, bits(64) modifier, bits(64) key0, bits(64) key1)
    bits(64)  workingval;
    bits(64)  runningmod;
    bits(64)  roundkey;
    bits(64)  modk0;
    constant bits(64) Alpha = 0xC0AC29B7C97C50DD<63:0>;

    RC[0] = 0x0000000000000000<63:0>;
    RC[1] = 0x13198A2E03707344<63:0>;
    RC[2] = 0xA4093822299F31D0<63:0>;
    RC[3] = 0x082EFA98EC4E6C89<63:0>;
    RC[4] = 0x452821E638D01377<63:0>;

    modk0 = key0<0>:key0<63:2>:(key0<63> EOR key0<1>);
    runningmod = modifier;
    workingval = data EOR key0;
    for i = 0 to 4
        roundkey = key1 EOR runningmod;
        workingval  = workingval EOR roundkey;
        workingval = workingval EOR RC[i];
        if i > 0 then
            workingval = PACCellShuffle(workingval);
            workingval = PACMult(workingval);
        workingval = PACSub(workingval);
        runningmod = TweakShuffle(runningmod<63:0>);
    roundkey = modk0 EOR runningmod;
    workingval = workingval EOR roundkey;
    workingval = PACCellShuffle(workingval);
    workingval = PACMult(workingval);
    workingval = PACSub(workingval);
    workingval = PACCellShuffle(workingval);
    workingval = PACMult(workingval);
    workingval = key1 EOR workingval;
    workingval = PACCellInvShuffle(workingval);
    workingval = PACInvSub(workingval);
    workingval = PACMult(workingval);
    workingval = PACCellInvShuffle(workingval);
    workingval = workingval EOR key0;
    workingval = workingval EOR runningmod;
    for i = 0 to 4
        workingval = PACInvSub(workingval);
        if i < 4 then
            workingval = PACMult(workingval);
            workingval = PACCellInvShuffle(workingval);
        runningmod = TweakInvShuffle(runningmod<63:0>);
        roundkey = key1 EOR runningmod;
        workingval = workingval EOR RC[4-i];
        workingval = workingval EOR roundkey;
        workingval = workingval EOR Alpha;
    workingval = workingval EOR modk0;

    return workingval;
```

Library pseudocode for aarch64/functions/pac/computepac/PACCellInvShuffle

```
// PACCellInvShuffle()
// ===================

bits(64) PACCellInvShuffle(bits(64) indata)
    bits(64) outdata;
    outdata<3:0> = indata<15:12>;
    outdata<7:4> = indata<27:24>;
    outdata<11:8> = indata<51:48>;
    outdata<15:12> = indata<39:36>;
    outdata<19:16> = indata<59:56>;
    outdata<23:20> = indata<47:44>;
    outdata<27:24> = indata<7:4>;
    outdata<31:28> = indata<19:16>;
    outdata<35:32> = indata<35:32>;
    outdata<39:36> = indata<55:52>;
    outdata<43:40> = indata<31:28>;
    outdata<47:44> = indata<11:8>;
    outdata<51:48> = indata<23:20>;
    outdata<55:52> = indata<3:0>;
    outdata<59:56> = indata<43:40>;
    outdata<63:60> = indata<63:60>;
    return outdata;
```

Library pseudocode for aarch64/functions/pac/computepac/PACCellShuffle

```
// PACCellShuffle()
// ================

bits(64) PACCellShuffle(bits(64) indata)
    bits(64) outdata;
    outdata<3:0> = indata<55:52>;
    outdata<7:4> = indata<27:24>;
    outdata<11:8> = indata<47:44>;
    outdata<15:12> = indata<3:0>;
    outdata<19:16> = indata<31:28>;
    outdata<23:20> = indata<51:48>;
    outdata<27:24> = indata<7:4>;
    outdata<31:28> = indata<43:40>;
    outdata<35:32> = indata<35:32>;
    outdata<39:36> = indata<15:12>;
    outdata<43:40> = indata<59:56>;
    outdata<47:44> = indata<23:20>;
    outdata<51:48> = indata<11:8>;
    outdata<55:52> = indata<39:36>;
    outdata<59:56> = indata<19:16>;
    outdata<63:60> = indata<63:60>;
    return outdata;
```

Library pseudocode for aarch64/functions/pac/computepac/PACInvSub

```
// PACInvSub()
// ===========

bits(64) PACInvSub(bits(64) Tinput)
    // This is a 4-bit substitution from the PRINCE-family cipher

    bits(64) Toutput;
    for i = 0 to 15
        case Tinput<4*i+3:4*i> of
            when '0000'  Toutput<4*i+3:4*i> = '0101';
            when '0001'  Toutput<4*i+3:4*i> = '1110';
            when '0010'  Toutput<4*i+3:4*i> = '1101';
            when '0011'  Toutput<4*i+3:4*i> = '1000';
            when '0100'  Toutput<4*i+3:4*i> = '1010';
            when '0101'  Toutput<4*i+3:4*i> = '1011';
            when '0110'  Toutput<4*i+3:4*i> = '0001';
            when '0111'  Toutput<4*i+3:4*i> = '1001';
            when '1000'  Toutput<4*i+3:4*i> = '0010';
            when '1001'  Toutput<4*i+3:4*i> = '0110';
            when '1010'  Toutput<4*i+3:4*i> = '1111';
            when '1011'  Toutput<4*i+3:4*i> = '0000';
            when '1100'  Toutput<4*i+3:4*i> = '0100';
            when '1101'  Toutput<4*i+3:4*i> = '1100';
            when '1110'  Toutput<4*i+3:4*i> = '0111';
            when '1111'  Toutput<4*i+3:4*i> = '0011';
    return Toutput;
```

Library pseudocode for aarch64/functions/pac/computepac/PACMult

```
// PACMult()
// =========

bits(64) PACMult(bits(64) Sinput)
    bits(4)  t0;
    bits(4)  t1;
    bits(4)  t2;
    bits(4)  t3;
    bits(64) Soutput;

    for i = 0 to 3
        t0<3:0> = RotCell(Sinput<4*(i+8)+3:4*(i+8)>, 1) EOR RotCell(Sinput<4*(i+4)+3:4*(i+4)>, 2);
        t0<3:0> = t0<3:0> EOR RotCell(Sinput<4*(i)+3:4*(i)>, 1);
        t1<3:0> = RotCell(Sinput<4*(i+12)+3:4*(i+12)>, 1) EOR RotCell(Sinput<4*(i+4)+3:4*(i+4)>, 1);
        t1<3:0> = t1<3:0> EOR RotCell(Sinput<4*(i)+3:4*(i)>, 2);
        t2<3:0> = RotCell(Sinput<4*(i+12)+3:4*(i+12)>, 2) EOR RotCell(Sinput<4*(i+8)+3:4*(i+8)>, 1);
        t2<3:0> = t2<3:0> EOR RotCell(Sinput<4*(i)+3:4*(i)>, 1);
        t3<3:0> = RotCell(Sinput<4*(i+12)+3:4*(i+12)>, 1) EOR RotCell(Sinput<4*(i+8)+3:4*(i+8)>, 2);
        t3<3:0> = t3<3:0> EOR RotCell(Sinput<4*(i+4)+3:4*(i+4)>, 1);
        Soutput<4*i+3:4*i> = t3<3:0>;
        Soutput<4*(i+4)+3:4*(i+4)> = t2<3:0>;
        Soutput<4*(i+8)+3:4*(i+8)> = t1<3:0>;
        Soutput<4*(i+12)+3:4*(i+12)> = t0<3:0>;
    return Soutput;
```

Library pseudocode for aarch64/functions/pac/computepac/PACSub

```
// PACSub()
// ========

bits(64) PACSub(bits(64) Tinput)
    // This is a 4-bit substitution from the PRINCE-family cipher
    bits(64) Toutput;
    for i = 0 to 15
        case Tinput<4*i+3:4*i> of
            when '0000'  Toutput<4*i+3:4*i> = '1011';
            when '0001'  Toutput<4*i+3:4*i> = '0110';
            when '0010'  Toutput<4*i+3:4*i> = '1000';
            when '0011'  Toutput<4*i+3:4*i> = '1111';
            when '0100'  Toutput<4*i+3:4*i> = '1100';
            when '0101'  Toutput<4*i+3:4*i> = '0000';
            when '0110'  Toutput<4*i+3:4*i> = '1001';
            when '0111'  Toutput<4*i+3:4*i> = '1110';
            when '1000'  Toutput<4*i+3:4*i> = '0011';
            when '1001'  Toutput<4*i+3:4*i> = '0111';
            when '1010'  Toutput<4*i+3:4*i> = '0100';
            when '1011'  Toutput<4*i+3:4*i> = '0101';
            when '1100'  Toutput<4*i+3:4*i> = '1101';
            when '1101'  Toutput<4*i+3:4*i> = '0010';
            when '1110'  Toutput<4*i+3:4*i> = '0001';
            when '1111'  Toutput<4*i+3:4*i> = '1010';
    return Toutput;
```

Library pseudocode for aarch64/functions/pac/computepac/RotCell

```
// RotCell()
// =========

bits(4) RotCell(bits(4) incell, integer amount)
    bits(8) tmp;
    bits(4) outcell;

    // assert amount>3 || amount<1;
    tmp<7:0> = incell<3:0>:incell<3:0>;
    outcell = tmp<7-amount:4-amount>;
    return outcell;
```

Library pseudocode for aarch64/functions/pac/computepac/TweakCellInvRot

```
// TweakCellInvRot()
// =================

bits(4) TweakCellInvRot(bits(4)incell)
    bits(4) outcell;
    outcell<3> = incell<2>;
    outcell<2> = incell<1>;
    outcell<1> = incell<0>;
    outcell<0> = incell<0> EOR incell<3>;
    return outcell;
```

Library pseudocode for aarch64/functions/pac/computepac/TweakCellRot

```
// TweakCellRot()
// ==============

bits(4) TweakCellRot(bits(4) incell)
    bits(4) outcell;
    outcell<3> = incell<0> EOR incell<1>;
    outcell<2> = incell<3>;
    outcell<1> = incell<2>;
    outcell<0> = incell<1>;
    return outcell;
```

Library pseudocode for aarch64/functions/pac/computepac/TweakInvShuffle

```
// TweakInvShuffle()
// =================

bits(64) TweakInvShuffle(bits(64)indata)
    bits(64) outdata;
    outdata<3:0> = TweakCellInvRot(indata<51:48>);
    outdata<7:4> = indata<55:52>;
    outdata<11:8> = indata<23:20>;
    outdata<15:12> = indata<27:24>;
    outdata<19:16> = indata<3:0>;
    outdata<23:20> = indata<7:4>;
    outdata<27:24> = TweakCellInvRot(indata<11:8>);
    outdata<31:28> = indata<15:12>;
    outdata<35:32> = TweakCellInvRot(indata<31:28>);
    outdata<39:36> = TweakCellInvRot(indata<63:60>);
    outdata<43:40> = TweakCellInvRot(indata<59:56>);
    outdata<47:44> = TweakCellInvRot(indata<19:16>);
    outdata<51:48> = indata<35:32>;
    outdata<55:52> = indata<39:36>;
    outdata<59:56> = indata<43:40>;
    outdata<63:60> = TweakCellInvRot(indata<47:44>);
    return outdata;
```

Library pseudocode for aarch64/functions/pac/computepac/TweakShuffle

```
// TweakShuffle()
// ==============

bits(64) TweakShuffle(bits(64) indata)
    bits(64) outdata;
    outdata<3:0> = indata<19:16>;
    outdata<7:4> = indata<23:20>;
    outdata<11:8> = TweakCellRot(indata<27:24>);
    outdata<15:12> = indata<31:28>;
    outdata<19:16> = TweakCellRot(indata<47:44>);
    outdata<23:20> = indata<11:8>;
    outdata<27:24> = indata<15:12>;
    outdata<31:28> = TweakCellRot(indata<35:32>);
    outdata<35:32> = indata<51:48>;
    outdata<39:36> = indata<55:52>;
    outdata<43:40> = indata<59:56>;
    outdata<47:44> = TweakCellRot(indata<63:60>);
    outdata<51:48> = TweakCellRot(indata<3:0>);
    outdata<55:52> = indata<7:4>;
    outdata<59:56> = TweakCellRot(indata<43:40>);
    outdata<63:60> = TweakCellRot(indata<39:36>);
    return outdata;
```

Library pseudocode for aarch64/functions/pac/pac/HaveEnhancedPAC

```
// HaveEnhancedPAC()
// =================
// Returns TRUE if support for EnhancedPAC is implemented, FALSE otherwise.

boolean HaveEnhancedPAC()
    return ( HavePACExt()
        && boolean IMPLEMENTATION_DEFINED "Has enhanced PAC functionality" );
```

Library pseudocode for aarch64/functions/pac/pac/HavePACExt

```
// HavePACExt()
// ============
// Returns TRUE if support for the PAC extension is implemented, FALSE otherwise.

boolean HavePACExt()
    return HasArchVersion(ARMv8p3);
```

Library pseudocode for aarch64/functions/pac/pac/PtrHasUpperAndLowerAddRanges

```
// PtrHasUpperAndLowerAddRanges()
// ==============================
// Returns TRUE if the pointer has upper and lower address ranges, FALSE otherwise.

boolean PtrHasUpperAndLowerAddRanges()
    return PSTATE.EL == EL1 || PSTATE.EL == EL0 || (PSTATE.EL == EL2 && HCR_EL2.E2H == '1');
```

Library pseudocode for aarch64/functions/pac/strip/Strip

```
// Strip()
// =======
// Strip() returns a 64-bit value containing A, but replacing the pointer authentication
// code field bits with the extension of the address bits. This can apply to either
// instructions or data, where, as the use of tagged pointers is distinct, it might be
// handled differently.

bits(64) Strip(bits(64) A, boolean data)
    boolean TrapEL2;
    boolean TrapEL3;
    bits(64) original_ptr;
    bits(64) extfield;
    boolean tbi = CalculateTBI(A, data);
    integer bottom_PAC_bit = CalculateBottomPACBit(A<55>);
    extfield = Replicate(A<55>, 64);

    if tbi then
        original_ptr = A<63:56>:extfield< 56-bottom_PAC_bit-1:0>:A<bottom_PAC_bit-1:0>;
    else
        original_ptr = extfield< 64-bottom_PAC_bit-1:0>:A<bottom_PAC_bit-1:0>;

    case PSTATE.EL of
        when EL0
            TrapEL2 = (EL2Enabled() && HCR_EL2.API == '0' &&
                       (HCR_EL2.TGE == '0' || HCR_EL2.E2H == '0'));
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL1
            TrapEL2 = EL2Enabled() && HCR_EL2.API == '0';
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL2
            TrapEL2 = FALSE;
            TrapEL3 = HaveEL(EL3) && SCR_EL3.API == '0';
        when EL3
            TrapEL2 = FALSE;
            TrapEL3 = FALSE;

    if TrapEL2 then TrapPACUse(EL2);
    elsif TrapEL3 then TrapPACUse(EL3);
    else  return original_ptr;
```

Library pseudocode for aarch64/functions/pac/trappacuse/TrapPACUse

```
// TrapPACUse()
// ============
// Used for the trapping of the pointer authentication functions by higher exception
// levels.

TrapPACUse(bits(2) target_el)
    assert HaveEL(target_el) && target_el !=  EL0 && UInt(target_el) >= UInt(PSTATE.EL);

    bits(64) preferred_exception_return = ThisInstrAddr();
    ExceptionRecord exception;
    vect_offset = 0;
    exception = ExceptionSyndrome(Exception_PACTrap);
    AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/functions/ras/AArch64.ESBOperation

```
// AArch64.ESBOperation()
// ======================
// Perform the AArch64 ESB operation, either for ESB executed in AArch64 state, or for
// ESB in AArch32 state when SError interrupts are routed to an Exception level using
// AArch64

AArch64.ESBOperation()

    route_to_el3 = HaveEL(EL3) && SCR_EL3.EA == '1';
    route_to_el2 = (EL2Enabled() &&
                    (HCR_EL2.TGE == '1' || HCR_EL2.AMO == '1'));

    target = if route_to_el3 then EL3 elsif route_to_el2 then EL2 else EL1;

    if target == EL1 then
        mask_active = PSTATE.EL IN {EL0, EL1};
    elsif HaveVirtHostExt() && target == EL2 && HCR_EL2.<E2H,TGE> == '11' then
        mask_active = PSTATE.EL IN {EL0, EL2};
    else
        mask_active = PSTATE.EL == target;

    mask_set = (PSTATE.A == '1' && (!HaveDoubleFaultExt() || SCR_EL3.EA == '0' ||
                                    PSTATE.EL != EL3 || SCR_EL3.NMEA == '0'));
    intdis = Halted() || ExternalDebugInterruptsDisabled(target);
    masked = (UInt(target) < UInt(PSTATE.EL)) || intdis || (mask_active && mask_set);

    // Check for a masked Physical SError pending
    if IsPhysicalSErrorPending() && masked then
        // This function might be called for an interworking case, and INTdis is masking
        // the SError interrupt.
        if ELUsingAArch32(S1TranslationRegime()) then
            syndrome32 = AArch32.PhysicalSErrorSyndrome();
            DISR = AArch32.ReportDeferredSError(syndrome32.AET, syndrome32.ExT);
        else
            implicit_esb = FALSE;
            syndrome64 = AArch64.PhysicalSErrorSyndrome(implicit_esb);
            DISR_EL1 = AArch64.ReportDeferredSError(syndrome64);
        ClearPendingPhysicalSError();               // Set ISR_EL1.A to 0

    return;
```

Library pseudocode for aarch64/functions/ras/AArch64.PhysicalSErrorSyndrome

```
// Return the SError syndrome
bits(25) AArch64.PhysicalSErrorSyndrome(boolean implicit_esb);
```

Library pseudocode for aarch64/functions/ras/AArch64.ReportDeferredSError

```
// AArch64.ReportDeferredSError()
// ==============================
// Generate deferred SError syndrome

bits(64) AArch64.ReportDeferredSError(bits(25) syndrome)
    bits(64) target;
    target<31>   = '1';              // A
    target<24>   = syndrome<24>;     // IDS
    target<23:0> = syndrome<23:0>;   // ISS
    return target;
```

Library pseudocode for aarch64/functions/ras/AArch64.vESBOperation

```
// AArch64.vESBOperation()
// =======================
// Perform the AArch64 ESB operation for virtual SError interrupts, either for ESB
// executed in AArch64 state, or for ESB in AArch32 state with EL2 using AArch64 state

AArch64.vESBOperation()
    assert PSTATE.EL IN {EL0, EL1} && EL2Enabled();

    // If physical SError interrupts are routed to EL2, and TGE is not set, then a virtual
    // SError interrupt might be pending
    vSEI_enabled = HCR_EL2.TGE == '0' && HCR_EL2.AMO == '1';
    vSEI_pending = vSEI_enabled && HCR_EL2.VSE == '1';
    vintdis      = Halted() || ExternalDebugInterruptsDisabled(EL1);
    vmasked      = vintdis || PSTATE.A == '1';

    // Check for a masked virtual SError pending
    if vSEI_pending && vmasked then
        // This function might be called for the interworking case, and INTdis is masking
        // the virtual SError interrupt.
        if ELUsingAArch32(EL1) then
            VDISR = AArch32.ReportDeferredSError(VDFSR<15:14>, VDFSR<12>);
        else
            VDISR_EL2 = AArch64.ReportDeferredSError(VSESR_EL2<24:0>);
        HCR_EL2.VSE = '0';                       // Clear pending virtual SError

    return;
```

Library pseudocode for aarch64/functions/registers/AArch64.MaybeZeroRegisterUppers

```
// AArch64.MaybeZeroRegisterUppers()
// =================================
// On taking an exception to  AArch64 from AArch32, it is CONSTRAINED UNPREDICTABLE whether the top
// 32 bits of registers visible at any lower Exception level using AArch32 are set to zero.

AArch64.MaybeZeroRegisterUppers()
    assert UsingAArch32();         // Always called from AArch32 state before entering AArch64 state

    if PSTATE.EL == EL0 && !ELUsingAArch32(EL1) then
        first = 0;  last = 14;  include_R15 = FALSE;
    elsif PSTATE.EL IN {EL0, EL1} && EL2Enabled() && !ELUsingAArch32(EL2) then
        first = 0;  last = 30;  include_R15 = FALSE;
    else
        first = 0;  last = 30;  include_R15 = TRUE;

    for n = first to last
        if (n != 15 || include_R15) && ConstrainUnpredictableBool(Unpredictable_ZEROUPPER) then
            _R[n]<63:32> = Zeros();

    return;
```

Library pseudocode for aarch64/functions/registers/AArch64.ResetGeneralRegisters

```
// AArch64.ResetGeneralRegisters()
// ===============================

AArch64.ResetGeneralRegisters()

    for i = 0 to 30
        X[i] = bits(64) UNKNOWN;

    return;
```

Library pseudocode for aarch64/functions/registers/AArch64.ResetSIMDFPRegisters

```
// AArch64.ResetSIMDFPRegisters()
// ==============================

AArch64.ResetSIMDFPRegisters()

    for i = 0 to 31
        V[i] = bits(128) UNKNOWN;

    return;
```

Library pseudocode for aarch64/functions/registers/AArch64.ResetSpecialRegisters

```
// AArch64.ResetSpecialRegisters()
// ===============================

AArch64.ResetSpecialRegisters()

    // AArch64 special registers
    SP_EL0 = bits(64) UNKNOWN;
    SP_EL1 = bits(64) UNKNOWN;
    SPSR_EL1 = bits(32) UNKNOWN;
    ELR_EL1  = bits(64) UNKNOWN;
    if HaveEL(EL2) then
        SP_EL2 = bits(64) UNKNOWN;
        SPSR_EL2 = bits(32) UNKNOWN;
        ELR_EL2  = bits(64) UNKNOWN;
    if HaveEL(EL3) then
        SP_EL3 = bits(64) UNKNOWN;
        SPSR_EL3 = bits(32) UNKNOWN;
        ELR_EL3  = bits(64) UNKNOWN;

    // AArch32 special registers that are not architecturally mapped to AArch64 registers
    if HaveAArch32EL(EL1) then
        SPSR_fiq = bits(32) UNKNOWN;
        SPSR_irq = bits(32) UNKNOWN;
        SPSR_abt = bits(32) UNKNOWN;
        SPSR_und = bits(32) UNKNOWN;

    // External debug special registers
    DLR_EL0 = bits(64) UNKNOWN;
    DSPSR_EL0 = bits(32) UNKNOWN;

    return;
```

Library pseudocode for aarch64/functions/registers/AArch64.ResetSystemRegisters

```
AArch64.ResetSystemRegisters(boolean cold_reset);
```

Library pseudocode for aarch64/functions/registers/PC

```
// PC - non-assignment form
// ========================
// Read program counter.

bits(64) PC[]
    return _PC;
```

Library pseudocode for aarch64/functions/registers/SP

```
// SP[] - assignment form
// ======================
// Write to stack pointer from either a 32-bit or a 64-bit value.

SP[] = bits(width) value
    assert width IN {32,64};
    if PSTATE.SP == '0' then
        SP_EL0 = ZeroExtend(value);
    else
        case PSTATE.EL of
            when EL0  SP_EL0 = ZeroExtend(value);
            when EL1  SP_EL1 = ZeroExtend(value);
            when EL2  SP_EL2 = ZeroExtend(value);
            when EL3  SP_EL3 = ZeroExtend(value);
    return;

// SP[] - non-assignment form
// ==========================
// Read stack pointer with implicit slice of 8, 16, 32 or 64 bits.

bits(width) SP[]
    assert width IN {8,16,32,64};
    if PSTATE.SP == '0' then
        return SP_EL0<width-1:0>;
    else
        case PSTATE.EL of
            when EL0  return SP_EL0<width-1:0>;
            when EL1  return SP_EL1<width-1:0>;
            when EL2  return SP_EL2<width-1:0>;
            when EL3  return SP_EL3<width-1:0>;
```

Library pseudocode for aarch64/functions/registers/V

```
// V[] - assignment form
// =====================
// Write to SIMD&FP register with implicit extension from
// 8, 16, 32, 64 or 128 bits.

V[integer n] = bits(width) value
    assert n >= 0 && n <= 31;
    assert width IN {8,16,32,64,128};
    integer vlen = if IsSVEEnabled(PSTATE.EL) then VL else 128;
    if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
        _Z[n] = ZeroExtend(value);
    else
        _Z[n]<vlen-1:0> = ZeroExtend(value);

// V[] - non-assignment form
// =========================
// Read from SIMD&FP register with implicit slice of 8, 16
// 32, 64 or 128 bits.

bits(width) V[integer n]
    assert n >= 0 && n <= 31;
    assert width IN {8,16,32,64,128};
    return _Z[n]<width-1:0>;
```

Library pseudocode for aarch64/functions/registers/Vpart

```
// Vpart[] - non-assignment form
// ============================
// Reads a 128-bit SIMD&FP register in up to two parts:
//  part 0 returns the bottom 8, 16, 32 or 64 bits of a value held in the register;
//  part 1 returns the top half of the bottom 64 bits or the top half of the 128-bit
//  value held in the register.

bits(width) Vpart[integer n, integer part]
    assert n >= 0 && n <= 31;
    assert part IN {0, 1};
    if part == 0 then
        assert width < 128;
        return V[n];
    else
        assert width IN {32,64};
        bits(128) vreg = V[n];
        return vreg<(width * 2)-1:width>;

// Vpart[] - assignment form
// =========================
// Writes a 128-bit SIMD&FP register in up to two parts:
//  part 0 zero extends a 8, 16, 32, or 64-bit value to fill the whole register;
//  part 1 inserts a 64-bit value into the top half of the register.

Vpart[integer n, integer part] = bits(width) value
    assert n >= 0 && n <= 31;
    assert part IN {0, 1};
    if part == 0 then
        assert width < 128;
        V[n] = value;
    else
        assert width == 64;
        bits(64) vreg = V[n];
        V[n] = value<63:0> : vreg;
```

Library pseudocode for aarch64/functions/registers/X

```
// X[] - assignment form
// =====================
// Write to general-purpose register from either a 32-bit or a 64-bit value.

X[integer n] = bits(width) value
    assert n >= 0 && n <= 31;
    assert width IN {32,64};
    if n != 31 then
        _R[n] = ZeroExtend(value);
    return;

// X[] - non-assignment form
// =========================
// Read from general-purpose register with implicit slice of 8, 16, 32 or 64 bits.

bits(width) X[integer n]
    assert n >= 0 && n <= 31;
    assert width IN {8,16,32,64};
    if n != 31 then
        return _R[n]<width-1:0>;
    else
        return Zeros(width);
```

Library pseudocode for aarch64/functions/sve/AArch32.IsFPEnabled

```
// AArch32.IsFPEnabled()
// =====================

boolean AArch32.IsFPEnabled(bits(2) el)
    if el == EL0 && !ELUsingAArch32(EL1) then
        return AArch64.IsFPEnabled(el);

    if HaveEL(EL3) && ELUsingAArch32(EL3) && !IsSecure() then
        // Check if access disabled in NSACR
        if NSACR.cp10 == '0' then return FALSE;

    if el IN {EL0, EL1} then
        // Check if access disabled in CPACR
        case CPACR.cp10 of
            when 'x0' disabled = TRUE;
            when '01' disabled = (el == EL0);
            when '11' disabled = FALSE;
        if disabled then return FALSE;

    if el IN {EL0, EL1, EL2} then
        if EL2Enabled() then
            if !ELUsingAArch32(EL2) then
                if CPTR_EL2.TFP == '1' then return FALSE;
            else
                if HCPTR.TCP10 == '1' then return FALSE;

    if HaveEL(EL3) && !ELUsingAArch32(EL3) then
        // Check if access disabled in CPTR_EL3
        if CPTR_EL3.TFP == '1' then return FALSE;

    return TRUE;
```

Library pseudocode for aarch64/functions/sve/AArch64.IsFPEnabled

```
// AArch64.IsFPEnabled()
// =====================

boolean AArch64.IsFPEnabled(bits(2) el)
    // Check if access disabled in CPACR_EL1
    if el IN {EL0, EL1} then
        // Check FP&SIMD at EL0/EL1
        case CPACR[].FPEN of
            when 'x0' disabled = TRUE;
            when '01' disabled = (el == EL0);
            when '11' disabled = FALSE;
        if disabled then return FALSE;

    // Check if access disabled in CPTR_EL2
    if el IN {EL0, EL1, EL2} && EL2Enabled() then
        if HaveVirtHostExt() && HCR_EL2.E2H == '1' then
            if CPTR_EL2.FPEN == 'x0' then return FALSE;
        else
            if CPTR_EL2.TFP == '1' then return FALSE;

    // Check if access disabled in CPTR_EL3
    if HaveEL(EL3) then
        if CPTR_EL3.TFP == '1' then return FALSE;

    return TRUE;
```

Library pseudocode for aarch64/functions/sve/BitDeposit

```
// BitDeposit()
// ============
// Deposit the least significant bits from DATA into result positions
// selected by non-zero bits in MASK, setting other result bits to zero.

bits(N) BitDeposit (bits(N) data, bits(N) mask)
    bits(N) res = Zeros();
    integer db = 0;
    for rb = 0 to N-1
        if mask<rb> == '1' then
            res<rb> = data<db>;
            db = db + 1;
    return res;
```

Library pseudocode for aarch64/functions/sve/BitExtract

```
// BitExtract()
// ============
// Extract and pack DATA bits selected by the non-zero bits in MASK into
// the least significant result bits, setting other result bits to zero.

bits(N) BitExtract (bits(N) data, bits(N) mask)
    bits(N) res = Zeros();
    integer rb = 0;
    for db = 0 to N-1
        if mask<db> == '1' then
            res<rb> = data<db>;
            rb = rb + 1;
    return res;
```

Library pseudocode for aarch64/functions/sve/BitGroup

```
// BitGroup()
// ==========
// Extract and pack DATA bits selected by the non-zero bits in MASK into
// the least significant result bits, and pack unselected bits into the
// most significant result bits.

bits(N) BitGroup (bits(N) data, bits(N) mask)
    bits(N) res;
    integer rb = 0;

    // compress masked bits to right
    for db = 0 to N-1
        if mask<db> == '1' then
            res<rb> = data<db>;
            rb = rb + 1;
    // compress unmasked bits to left
    for db = 0 to N-1
        if mask<db> == '0' then
            res<rb> = data<db>;
            rb = rb + 1;
    return res;
```

Library pseudocode for aarch64/functions/sve/CeilPow2

```
// CeilPow2()
// ==========

// For a positive integer X, return the smallest power of 2 >= X

integer CeilPow2(integer x)
    if x == 0 then return 0;
    if x == 1 then return 2;
    return FloorPow2(x - 1) * 2;
```

Library pseudocode for aarch64/functions/sve/CheckSVEEnabled

```
// CheckSVEEnabled()
// =================

CheckSVEEnabled()
    // Check if access disabled in CPACR_EL1
    if PSTATE.EL IN {EL0, EL1} then
        // Check SVE at EL0/EL1
        case CPACR[].ZEN of
            when 'x0'  disabled = TRUE;
            when '01'  disabled = PSTATE.EL == EL0;
            when '11'  disabled = FALSE;
        if disabled then SVEAccessTrap(EL1);

        // Check FP&SIMD at EL0/EL1
        case CPACR[].FPEN of
            when 'x0'  disabled = TRUE;
            when '01'  disabled = PSTATE.EL == EL0;
            when '11'  disabled = FALSE;
        if disabled then AArch64.AdvSIMDFPAccessTrap(EL1);

    if PSTATE.EL IN {EL0, EL1, EL2} && EL2Enabled() then
        if HaveVirtHostExt() && HCR_EL2.E2H == '1' then
            if CPTR_EL2.ZEN == 'x0' then SVEAccessTrap(EL2);
            if CPTR_EL2.FPEN == 'x0' then AArch64.AdvSIMDFPAccessTrap(EL2);
        else
            if CPTR_EL2.TZ == '1' then SVEAccessTrap(EL2);
            if CPTR_EL2.TFP == '1' then AArch64.AdvSIMDFPAccessTrap(EL2);

    // Check if access disabled in CPTR_EL3
    if HaveEL(EL3) then
        if CPTR_EL3.EZ == '0' then SVEAccessTrap(EL3);
        if CPTR_EL3.TFP == '1' then AArch64.AdvSIMDFPAccessTrap(EL3);
```

Library pseudocode for aarch64/functions/sve/DecodePredCount

```
// DecodePredCount()
// =================

integer DecodePredCount(bits(5) pattern, integer esize)
    integer elements = VL DIV esize;
    integer numElem;
    case pattern of
        when '00000' numElem = FloorPow2(elements);
        when '00001' numElem = if elements >= 1 then 1 else 0;
        when '00010' numElem = if elements >= 2 then 2 else 0;
        when '00011' numElem = if elements >= 3 then 3 else 0;
        when '00100' numElem = if elements >= 4 then 4 else 0;
        when '00101' numElem = if elements >= 5 then 5 else 0;
        when '00110' numElem = if elements >= 6 then 6 else 0;
        when '00111' numElem = if elements >= 7 then 7 else 0;
        when '01000' numElem = if elements >= 8 then 8 else 0;
        when '01001' numElem = if elements >= 16 then 16 else 0;
        when '01010' numElem = if elements >= 32 then 32 else 0;
        when '01011' numElem = if elements >= 64 then 64 else 0;
        when '01100' numElem = if elements >= 128 then 128 else 0;
        when '01101' numElem = if elements >= 256 then 256 else 0;
        when '11101' numElem = elements - (elements MOD 4);
        when '11110' numElem = elements - (elements MOD 3);
        when '11111' numElem = elements;
        otherwise    numElem = 0;
    return numElem;
```

Library pseudocode for aarch64/functions/sve/ElemFFR

```
// ElemFFR[] - non-assignment form
// ===============================

bit ElemFFR[integer e, integer esize]
    return ElemP[_FFR, e, esize];

// ElemFFR[] - assignment form
// ===========================

ElemFFR[integer e, integer esize] = bit value
    integer psize = esize DIV 8;
    integer n = e * psize;
    assert n >= 0 && (n + psize) <= PL;
    _FFR<n+psize-1:n> = ZeroExtend(value, psize);
    return;
```

Library pseudocode for aarch64/functions/sve/ElemP

```
// ElemP[] - non-assignment form
// =============================

bit ElemP[bits(N) pred, integer e, integer esize]
    integer n = e * (esize DIV 8);
    assert n >= 0 && n < N;
    return pred<n>;

// ElemP[] - assignment form
// =========================

ElemP[bits(N) &pred, integer e, integer esize] = bit value
    integer psize = esize DIV 8;
    integer n = e * psize;
    assert n >= 0 && (n + psize) <= N;
    pred<n+psize-1:n> = ZeroExtend(value, psize);
    return;
```

Library pseudocode for aarch64/functions/sve/FFR

```
// FFR[] - non-assignment form
// ===========================

bits(width) FFR[]
    assert width == PL;
    return _FFR<width-1:0>;

// FFR[] - assignment form
// =======================

FFR[] = bits(width) value
    assert width == PL;
    if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
        _FFR = ZeroExtend(value);
    else
        _FFR<width-1:0> = value;
```

Library pseudocode for aarch64/functions/sve/FPCompareNE

```
// FPCompareNE()
// =============

boolean FPCompareNE(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    if type1==FPType_SNaN || type1==FPType_QNaN || type2==FPType_SNaN || type2==FPType_QNaN then
        result = TRUE;
        if type1==FPType_SNaN || type2==FPType_SNaN then
            FPProcessException(FPExc_InvalidOp, fpcr);
    else // All non-NaN cases can be evaluated on the values produced by FPUnpack()
        result = (value1 != value2);
    return result;
```

Library pseudocode for aarch64/functions/sve/FPCompareUN

```
// FPCompareUN()
// =============

boolean FPCompareUN(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    if type1==FPType_SNaN || type2==FPType_SNaN then
        FPProcessException(FPExc_InvalidOp, fpcr);
    return (type1==FPType_SNaN || type1==FPType_QNaN || type2==FPType_SNaN || type2==FPType_QNaN);
```

Library pseudocode for aarch64/functions/sve/FPConvertSVE

```
// FPConvertSVE()
// ==============

bits(M) FPConvertSVE(bits(N) op, FPCRType fpcr, FPRounding rounding)
    fpcr.AHP = '0';
    return FPConvert(op, fpcr, rounding);

// FPConvertSVE()
// ==============

bits(M) FPConvertSVE(bits(N) op, FPCRType fpcr)
    fpcr.AHP = '0';
    return FPConvert(op, fpcr, FPRoundingMode(fpcr));
```

Library pseudocode for aarch64/functions/sve/FPExpA

```
// FPExpA()
// ========

bits(N) FPExpA(bits(N) op)
    assert N IN {16,32,64};
    bits(N) result;
    bits(N) coeff;
    integer idx = if N == 16 then UInt(op<4:0>) else UInt(op<5:0>);
    coeff = FPExpCoefficient[idx];
    if N == 16 then
        result<15:0> = '0':op<9:5>:coeff<9:0>;
    elsif N == 32 then
        result<31:0> = '0':op<13:6>:coeff<22:0>;
    else // N == 64
        result<63:0> = '0':op<16:6>:coeff<51:0>;

    return result;
```

Library pseudocode for aarch64/functions/sve/FPExpCoefficient

```
// FPExpCoefficient()
// ==================

bits(N) FPExpCoefficient[integer index]
    assert N IN {16,32,64};
    integer result;

    if N == 16 then
        case index of
            when  0 result = 0x0000;
            when  1 result = 0x0016;
            when  2 result = 0x002d;
            when  3 result = 0x0045;
            when  4 result = 0x005d;
            when  5 result = 0x0075;
            when  6 result = 0x008e;
            when  7 result = 0x00a8;
            when  8 result = 0x00c2;
            when  9 result = 0x00dc;
            when 10 result = 0x00f8;
            when 11 result = 0x0114;
            when 12 result = 0x0130;
            when 13 result = 0x014d;
            when 14 result = 0x016b;
            when 15 result = 0x0189;
            when 16 result = 0x01a8;
            when 17 result = 0x01c8;
            when 18 result = 0x01e8;
            when 19 result = 0x0209;
            when 20 result = 0x022b;
            when 21 result = 0x024e;
            when 22 result = 0x0271;
            when 23 result = 0x0295;
            when 24 result = 0x02ba;
            when 25 result = 0x02e0;
            when 26 result = 0x0306;
            when 27 result = 0x032e;
            when 28 result = 0x0356;
            when 29 result = 0x037f;
            when 30 result = 0x03a9;
            when 31 result = 0x03d4;

    elsif N == 32 then
        case index of
            when  0 result = 0x000000;
            when  1 result = 0x0164d2;
            when  2 result = 0x02cd87;
            when  3 result = 0x043a29;
            when  4 result = 0x05aac3;
            when  5 result = 0x071f62;
            when  6 result = 0x08980f;
            when  7 result = 0x0a14d5;
            when  8 result = 0x0b95c2;
            when  9 result = 0x0d1adf;
            when 10 result = 0x0ea43a;
            when 11 result = 0x1031dc;
            when 12 result = 0x11c3d3;
            when 13 result = 0x135a2b;
            when 14 result = 0x14f4f0;
            when 15 result = 0x16942d;
            when 16 result = 0x1837f0;
            when 17 result = 0x19e046;
            when 18 result = 0x1b8d3a;
            when 19 result = 0x1d3eda;
            when 20 result = 0x1ef532;
            when 21 result = 0x20b051;
            when 22 result = 0x227043;
            when 23 result = 0x243516;
            when 24 result = 0x25fed7;
            when 25 result = 0x27cd94;
```

```
        when 26 result = 0x29a15b;
        when 27 result = 0x2b7a3a;
        when 28 result = 0x2d583f;
        when 29 result = 0x2f3b79;
        when 30 result = 0x3123f6;
        when 31 result = 0x3311c4;
        when 32 result = 0x3504f3;
        when 33 result = 0x36fd92;
        when 34 result = 0x38fbaf;
        when 35 result = 0x3aff5b;
        when 36 result = 0x3d08a4;
        when 37 result = 0x3f179a;
        when 38 result = 0x412c4d;
        when 39 result = 0x4346cd;
        when 40 result = 0x45672a;
        when 41 result = 0x478d75;
        when 42 result = 0x49b9be;
        when 43 result = 0x4bec15;
        when 44 result = 0x4e248c;
        when 45 result = 0x506334;
        when 46 result = 0x52a81e;
        when 47 result = 0x54f35b;
        when 48 result = 0x5744fd;
        when 49 result = 0x599d16;
        when 50 result = 0x5bfbb8;
        when 51 result = 0x5e60f5;
        when 52 result = 0x60ccdf;
        when 53 result = 0x633f89;
        when 54 result = 0x65b907;
        when 55 result = 0x68396a;
        when 56 result = 0x6ac0c7;
        when 57 result = 0x6d4f30;
        when 58 result = 0x6fe4ba;
        when 59 result = 0x728177;
        when 60 result = 0x75257d;
        when 61 result = 0x77d0df;
        when 62 result = 0x7a83b3;
        when 63 result = 0x7d3e0c;

else // N == 64
    case index of
        when  0 result = 0x0000000000000;
        when  1 result = 0x02C9A3E778061;
        when  2 result = 0x059B0D3158574;
        when  3 result = 0x0874518759BC8;
        when  4 result = 0x0B5586CF9890F;
        when  5 result = 0x0E3EC32D3D1A2;
        when  6 result = 0x11301D0125B51;
        when  7 result = 0x1429AAEA92DE0;
        when  8 result = 0x172B83C7D517B;
        when  9 result = 0x1A35BEB6FCB75;
        when 10 result = 0x1D4873168B9AA;
        when 11 result = 0x2063B88628CD6;
        when 12 result = 0x2387A6E756238;
        when 13 result = 0x26B4565E27CDD;
        when 14 result = 0x29E9DF51FDEE1;
        when 15 result = 0x2D285A6E4030B;
        when 16 result = 0x306FE0A31B715;
        when 17 result = 0x33C08B26416FF;
        when 18 result = 0x371A7373AA9CB;
        when 19 result = 0x3A7DB34E59FF7;
        when 20 result = 0x3DEA64C123422;
        when 21 result = 0x4160A21F72E2A;
        when 22 result = 0x44E086061892D;
        when 23 result = 0x486A2B5C13CD0;
        when 24 result = 0x4BFDAD5362A27;
        when 25 result = 0x4F9B2769D2CA7;
        when 26 result = 0x5342B569D4F82;
        when 27 result = 0x56F4736B527DA;
        when 28 result = 0x5AB07DD485429;
```

```
            when 29 result = 0x5E76F15AD2148;
            when 30 result = 0x6247EB03A5585;
            when 31 result = 0x6623882552225;
            when 32 result = 0x6A09E667F3BCD;
            when 33 result = 0x6DFB23C651A2F;
            when 34 result = 0x71F75E8EC5F74;
            when 35 result = 0x75FEB564267C9;
            when 36 result = 0x7A11473EB0187;
            when 37 result = 0x7E2F336CF4E62;
            when 38 result = 0x82589994CCE13;
            when 39 result = 0x868D99B4492ED;
            when 40 result = 0x8ACE5422AA0DB;
            when 41 result = 0x8F1AE99157736;
            when 42 result = 0x93737B0CDC5E5;
            when 43 result = 0x97D829FDE4E50;
            when 44 result = 0x9C49182A3F090;
            when 45 result = 0xA0C667B5DE565;
            when 46 result = 0xA5503B23E255D;
            when 47 result = 0xA9E6B5579FDBF;
            when 48 result = 0xAE89F995AD3AD;
            when 49 result = 0xB33A2B84F15FB;
            when 50 result = 0xB7F76F2FB5E47;
            when 51 result = 0xBCC1E904BC1D2;
            when 52 result = 0xC199BDD85529C;
            when 53 result = 0xC67F12E57D14B;
            when 54 result = 0xCB720DCEF9069;
            when 55 result = 0xD072D4A07897C;
            when 56 result = 0xD5818DCFBA487;
            when 57 result = 0xDA9E603DB3285;
            when 58 result = 0xDFC97337B9B5F;
            when 59 result = 0xE502EE78B3FF6;
            when 60 result = 0xEA4AFA2A490DA;
            when 61 result = 0xEFA1BEE615A27;
            when 62 result = 0xF50765B6E4540;
            when 63 result = 0xFA7C1819E90D8;

    return result<N-1:0>;
```

Library pseudocode for aarch64/functions/sve/FPLogB

```
// FPLogB()
// ========

bits(N) FPLogB(bits(N) op, FPCRType fpcr)
    assert N IN {16,32,64};

    (fptype,sign,value) = FPUnpack(op, fpcr);
    if fptype == FPType_SNaN || fptype == FPType_QNaN || fptype == FPType_Zero then
        FPProcessException(FPExc_InvalidOp, fpcr);
        result = -(2^(N-1));                    // MinInt, 100..00
    elsif fptype == FPType_Infinity then
        result = 2^(N-1) - 1;                   // MaxInt, 011..11
    else
        // FPUnpack has already scaled a subnormal input
        value = Abs(value);
        result = 0;
        while value < 1.0 do
            value = value * 2.0;
            result = result - 1;
        while value >= 2.0 do
            value = value / 2.0;
            result = result + 1;
    return result<N-1:0>;
```

Library pseudocode for aarch64/functions/sve/FPMinNormal

```
// FPMinNormal()
// =============

bits(N) FPMinNormal(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp = Zeros(E-1):'1';
    frac = Zeros(F);
    return sign : exp : frac;
```

Library pseudocode for aarch64/functions/sve/FPOne

```
// FPOne()
// =======

bits(N) FPOne(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp = '0':Ones(E-1);
    frac = Zeros(F);
    return sign : exp : frac;
```

Library pseudocode for aarch64/functions/sve/FPPointFive

```
// FPPointFive()
// =============

bits(N) FPPointFive(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp = '0':Ones(E-2):'0';
    frac = Zeros(F);
    return sign : exp : frac;
```

Library pseudocode for aarch64/functions/sve/FPProcess

```
// FPProcess()
// ===========

bits(N) FPProcess(bits(N) input)
    bits(N) result;
    assert N IN {16,32,64};
    (fptype,sign,value) = FPUnpack(input, FPCR);
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, input, FPCR);
    elsif fptype == FPType_Infinity then
        result = FPInfinity(sign);
    elsif fptype == FPType_Zero then
        result = FPZero(sign);
    else
        result = FPRound(value, FPCR);
    return result;
```

Library pseudocode for aarch64/functions/sve/FPScale

```
// FPScale()
// =========

bits(N) FPScale(bits (N) op, integer scale, FPCRType fpcr)
    assert N IN {16,32,64};
    (fptype,sign,value) = FPUnpack(op, fpcr);
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, op, fpcr);
    elsif fptype == FPType_Zero then
        result = FPZero(sign);
    elsif fptype == FPType_Infinity then
        result = FPInfinity(sign);
    else
        result = FPRound(value * (2.0^scale), fpcr);
    return result;
```

Library pseudocode for aarch64/functions/sve/FPTrigMAdd

```
// FPTrigMAdd()
// ============

bits(N) FPTrigMAdd(integer x, bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    assert x >= 0;
    assert x < 8;
    bits(N) coeff;

    if op2<N-1> == '1' then
        x = x + 8;
    op2<N-1> = '0';

    coeff = FPTrigMAddCoefficient[x];
    result = FPMulAdd(coeff, op1, op2, fpcr);

    return result;
```

Library pseudocode for aarch64/functions/sve/FPTrigMAddCoefficient

```
// FPTrigMAddCoefficient()
// =======================

bits(N) FPTrigMAddCoefficient[integer index]
    assert N IN {16,32,64};
    integer result;

    if N == 16 then
        case index of
            when  0 result = 0x3c00;
            when  1 result = 0xb155;
            when  2 result = 0x2030;
            when  3 result = 0x0000;
            when  4 result = 0x0000;
            when  5 result = 0x0000;
            when  6 result = 0x0000;
            when  7 result = 0x0000;
            when  8 result = 0x3c00;
            when  9 result = 0xb800;
            when 10 result = 0x293a;
            when 11 result = 0x0000;
            when 12 result = 0x0000;
            when 13 result = 0x0000;
            when 14 result = 0x0000;
            when 15 result = 0x0000;
    elsif N == 32 then
        case index of
            when  0 result = 0x3f800000;
            when  1 result = 0xbe2aaaab;
            when  2 result = 0x3c088886;
            when  3 result = 0xb95008b9;
            when  4 result = 0x36369d6d;
            when  5 result = 0x00000000;
            when  6 result = 0x00000000;
            when  7 result = 0x00000000;
            when  8 result = 0x3f800000;
            when  9 result = 0xbf000000;
            when 10 result = 0x3d2aaaa6;
            when 11 result = 0xbab60705;
            when 12 result = 0x37cd37cc;
            when 13 result = 0x00000000;
            when 14 result = 0x00000000;
            when 15 result = 0x00000000;
    else // N == 64
        case index of
            when  0 result = 0x3ff0000000000000;
            when  1 result = 0xbfc5555555555543;
            when  2 result = 0x3f8111111110f30c;
            when  3 result = 0xbf2a01a019b92fc6;
            when  4 result = 0x3ec71de351f3d22b;
            when  5 result = 0xbe5ae5e2b60f7b91;
            when  6 result = 0x3de5d8408868552f;
            when  7 result = 0x0000000000000000;
            when  8 result = 0x3ff0000000000000;
            when  9 result = 0xbfe0000000000000;
            when 10 result = 0x3fa5555555555536;
            when 11 result = 0xbf56c16c16c13a0b;
            when 12 result = 0x3efa01a019b1e8d8;
            when 13 result = 0xbe927e4f7282f468;
            when 14 result = 0x3e21ee96d2641b13;
            when 15 result = 0xbda8f76380fbb401;

    return result<N-1:0>;
```

Library pseudocode for aarch64/functions/sve/FPTrigSMul

```
// FPTrigSMul()
// ============

bits(N) FPTrigSMul(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    result = FPMul(op1, op1, fpcr);
    (fptype, sign, value) = FPUnpack(result, fpcr);
    if (fptype != FPType_QNaN) && (fptype != FPType_SNaN) then
        result<N-1> = op2<0>;

    return result;
```

Library pseudocode for aarch64/functions/sve/FPTrigSSel

```
// FPTrigSSel()
// ============

bits(N) FPTrigSSel(bits(N) op1, bits(N) op2)
    assert N IN {16,32,64};
    bits(N) result;

    if op2<0> == '1' then
        result = FPOne(op2<1>);
    else
        result = op1;
        result<N-1> = result<N-1> EOR op2<1>;

    return result;
```

Library pseudocode for aarch64/functions/sve/FirstActive

```
// FirstActive()
// =============

bit FirstActive(bits(N) mask, bits(N) x, integer esize)
    integer elements = N DIV (esize DIV 8);
    for e = 0 to elements-1
        if ElemP[mask, e, esize] == '1' then return ElemP[x, e, esize];
    return '0';
```

Library pseudocode for aarch64/functions/sve/FloorPow2

```
// FloorPow2()
// ===========
// For a positive integer X, return the largest power of 2 <= X

integer FloorPow2(integer x)
    assert x >= 0;
    integer n = 1;
    if x == 0 then return 0;
    while x >= 2^n do
        n = n + 1;
    return 2^(n - 1);
```

Library pseudocode for aarch64/functions/sve/HaveSVE

```
// HaveSVE()
// =========

boolean HaveSVE()
    return HasArchVersion(ARMv8p2) && boolean IMPLEMENTATION_DEFINED "Have SVE ISA";
```

Library pseudocode for aarch64/functions/sve/HaveSVE2

```
// HaveSVE2()
// ==========
// Returns TRUE if the SVE2 extension is implemented, FALSE otherwise.

boolean HaveSVE2()
    return HaveSVE() && boolean IMPLEMENTATION_DEFINED "Have SVE2 extension";
```

Library pseudocode for aarch64/functions/sve/HaveSVE2AES

```
// HaveSVE2AES()
// =============
// Returns TRUE if the SVE2 AES extension is implemented, FALSE otherwise.

boolean HaveSVE2AES()
    return HaveSVE2() && boolean IMPLEMENTATION_DEFINED "Have SVE2 AES extension";
```

Library pseudocode for aarch64/functions/sve/HaveSVE2BitPerm

```
// HaveSVE2BitPerm()
// =================
// Returns TRUE if the SVE2 Bit Permissions extension is implemented, FALSE otherwise.

boolean HaveSVE2BitPerm()
    return HaveSVE2() && boolean IMPLEMENTATION_DEFINED "Have SVE2 BitPerm extension";
```

Library pseudocode for aarch64/functions/sve/HaveSVE2PMULL128

```
// HaveSVE2PMULL128()
// ==================
// Returns TRUE if the SVE2 128 bit PMULL extension is implemented, FALSE otherwise.

boolean HaveSVE2PMULL128()
    return HaveSVE2() && boolean IMPLEMENTATION_DEFINED "Have SVE2 128 bit PMULL extension";
```

Library pseudocode for aarch64/functions/sve/HaveSVE2SHA3

```
// HaveSVE2SHA3()
// ==============
// Returns TRUE if the SVE2 SHA3 extension is implemented, FALSE otherwise.

boolean HaveSVE2SHA3()
    return HaveSVE2() && boolean IMPLEMENTATION_DEFINED "Have SVE2 SHA3 extension";
```

Library pseudocode for aarch64/functions/sve/HaveSVE2SM4

```
// HaveSVE2SM4()
// =============
// Returns TRUE if the SVE2 SM4 extension is implemented, FALSE otherwise.

boolean HaveSVE2SM4()
    return HaveSVE2() && boolean IMPLEMENTATION_DEFINED "Have SVE2 SM4 extension";
```

Library pseudocode for aarch64/functions/sve/ImplementedSVEVectorLength

```
// ImplementedSVEVectorLength()
// ============================
// Reduce SVE vector length to a supported value (e.g. power of two)

integer ImplementedSVEVectorLength(integer nbits)
    return integer IMPLEMENTATION_DEFINED;
```

Library pseudocode for aarch64/functions/sve/IsEven

```
// IsEven()
// ========

boolean IsEven(integer val)
    return val MOD 2 == 0;
```

Library pseudocode for aarch64/functions/sve/IsFPEnabled

```
// IsFPEnabled()
// =============

boolean IsFPEnabled(bits(2) el)
    if ELUsingAArch32(el) then
        return AArch32.IsFPEnabled(el);
    else
        return AArch64.IsFPEnabled(el);
```

Library pseudocode for aarch64/functions/sve/IsOdd

```
// IsOdd()
// =======

boolean IsOdd(integer val)
    return val MOD 2 == 1;
```

Library pseudocode for aarch64/functions/sve/IsSVEEnabled

```
// IsSVEEnabled()
// ==============

boolean IsSVEEnabled(bits(2) el)
    if ELUsingAArch32(el) then
        return FALSE;

    // Check if access disabled in CPACR_EL1
    if el IN {EL0, EL1} then
        // Check SVE at EL0/EL1
        case CPACR[].ZEN of
            when 'x0'  disabled = TRUE;
            when '01'  disabled = (el == EL0);
            when '11'  disabled = FALSE;
        if disabled then return FALSE;

    // Check if access disabled in CPTR_EL2
    if el IN {EL0, EL1, EL2} && EL2Enabled() then
        if HaveVirtHostExt() && HCR_EL2.E2H == '1' then
            if CPTR_EL2.ZEN == 'x0' then return FALSE;
        else
            if CPTR_EL2.TZ == '1' then return FALSE;

    // Check if access disabled in CPTR_EL3
    if HaveEL(EL3) then
        if CPTR_EL3.EZ == '0' then return FALSE;

    return TRUE;
```

Library pseudocode for aarch64/functions/sve/LastActive

```
// LastActive()
// ============

bit LastActive(bits(N) mask, bits(N) x, integer esize)
    integer elements = N DIV (esize DIV 8);
    for e = elements-1 downto 0
        if ElemP[mask, e, esize] == '1' then return ElemP[x, e, esize];
    return '0';
```

Library pseudocode for aarch64/functions/sve/LastActiveElement

```
// LastActiveElement()
// ===================

integer LastActiveElement(bits(N) mask, integer esize)
    assert esize IN {8, 16, 32, 64};
    integer elements = VL DIV esize;
    for e = elements-1 downto 0
        if ElemP[mask, e, esize] == '1' then return e;
    return -1;
```

Library pseudocode for aarch64/functions/sve/MAX_PL

```
constant integer MAX_PL = 256;
```

Library pseudocode for aarch64/functions/sve/MAX_VL

```
constant integer MAX_VL = 2048;
```

Library pseudocode for aarch64/functions/sve/MaybeZeroSVEUppers

```
// MaybeZeroSVEUppers()
// ====================

MaybeZeroSVEUppers(bits(2) target_el)
    boolean lower_enabled;

    if UInt(target_el) <= UInt(PSTATE.EL) || !IsSVEEnabled(target_el) then
        return;

    if target_el == EL3 then
        if EL2Enabled() then
            lower_enabled = IsFPEnabled(EL2);
        else
            lower_enabled = IsFPEnabled(EL1);
    else
        lower_enabled = IsFPEnabled(target_el - 1);

    if lower_enabled then
        integer vl = if IsSVEEnabled(PSTATE.EL) then VL else 128;
        integer pl = vl DIV 8;
        for n = 0 to 31
            if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
                _Z[n] = ZeroExtend(_Z[n]<vl-1:0>);
        for n = 0 to 15
            if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
                _P[n] = ZeroExtend(_P[n]<pl-1:0>);
        if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
            _FFR = ZeroExtend(_FFR<pl-1:0>);
```

Library pseudocode for aarch64/functions/sve/MemNF

```
// MemNF[] - non-assignment form
// =============================

(bits(8*size), boolean) MemNF[bits(64) address, integer size, AccType acctype]
    assert size IN {1, 2, 4, 8, 16};
    bits(8*size) value;

    aligned = (address == Align(address, size));
    A = SCTLR[].A;

    if !aligned && (A == '1') then
        return (bits(8*size) UNKNOWN, TRUE);

    atomic = aligned || size == 1;

    if !atomic then
        (value<7:0>, bad) = MemSingleNF[address, 1, acctype, aligned];

        if bad then
            return (bits(8*size) UNKNOWN, TRUE);

        // For subsequent bytes it is CONSTRAINED UNPREDICTABLE whether an unaligned Device memory
        // access will generate an Alignment Fault, as to get this far means the first byte did
        // not, so we must be changing to a new translation page.
        if !aligned then
            c = ConstrainUnpredictable(Unpredictable_DEVPAGE2);
            assert c IN {Constraint_FAULT, Constraint_NONE};
            if c == Constraint_NONE then aligned = TRUE;

        for i = 1 to size-1
            (value<8*i+7:8*i>, bad) = MemSingleNF[address+i, 1, acctype, aligned];

            if bad then
                return (bits(8*size) UNKNOWN, TRUE);
    else
        (value, bad) = MemSingleNF[address, size, acctype, aligned];
        if bad then
            return (bits(8*size) UNKNOWN, TRUE);

    if BigEndian() then
        value = BigEndianReverse(value);

    return (value, FALSE);
```

Library pseudocode for aarch64/functions/sve/MemSingleNF

```
// MemSingleNF[] - non-assignment form
// ===================================

(bits(8*size), boolean) MemSingleNF[bits(64) address, integer size, AccType acctype, boolean wasaligned]
    bits(8*size) value;
    boolean iswrite = FALSE;
    AddressDescriptor memaddrdesc;

    // Implementation may suppress NF load for any reason
    if ConstrainUnpredictableBool(Unpredictable_NONFAULT) then
        return (bits(8*size) UNKNOWN, TRUE);

    // MMU or MPU
    memaddrdesc = AArch64.TranslateAddress(address, acctype, iswrite, wasaligned, size);

    // Non-fault load from Device memory must not be performed externally
    if memaddrdesc.memattrs.memtype == MemType_Device then
        return (bits(8*size) UNKNOWN, TRUE);

    // Check for aborts or debug exceptions
    if IsFault(memaddrdesc) then
        return (bits(8*size) UNKNOWN, TRUE);

    // Memory array access
    transactional = TSTATE.depth > 0;
    accdesc =     accdesc = CreateAccessDescriptor(acctype, transactional);
    if CreateAccessDescriptor(acctype, transactional);
    if HaveMTEExt() then
        if AArch64.AccessIsTagChecked(address, acctype) then
            bits(4) ptag = AArch64.PhysicalTagAArch64.TransformTag(address);
            if !AArch64.CheckTag(memaddrdesc, ptag, iswrite) then
                return (bits(8*size) UNKNOWN, TRUE);
    value = _Mem[memaddrdesc, size, accdesc];

    return (value, FALSE);
```

Library pseudocode for aarch64/functions/sve/NoneActive

```
// NoneActive()
// ============

bit NoneActive(bits(N) mask, bits(N) x, integer esize)
    integer elements = N DIV (esize DIV 8);
    for e = 0 to elements-1
        if ElemP[mask, e, esize] == '1' && ElemP[x, e, esize] == '1' then return '0';
    return '1';
```

Library pseudocode for aarch64/functions/sve/P

```
// P[] - non-assignment form
// =========================

bits(width) P[integer n]
    assert n >= 0 && n <= 31;
    assert width == PL;
    return _P[n]<width-1:0>;

// P[] - assignment form
// =====================

P[integer n] = bits(width) value
    assert n >= 0 && n <= 31;
    assert width == PL;
    if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
        _P[n] = ZeroExtend(value);
    else
        _P[n]<width-1:0> = value;
```

Library pseudocode for aarch64/functions/sve/PL

```
// PL - non-assignment form
// ========================

integer PL
    return VL DIV 8;
```

Library pseudocode for aarch64/functions/sve/PredTest

```
// PredTest()
// ==========

bits(4) PredTest(bits(N) mask, bits(N) result, integer esize)
    bit n = FirstActive(mask, result, esize);
    bit z = NoneActive(mask, result, esize);
    bit c = NOT LastActive(mask, result, esize);
    bit v = '0';
    return n:z:c:v;
```

Library pseudocode for aarch64/functions/sve/ReducePredicated

```
// ReducePredicated()
// ==================

bits(esize) ReducePredicated(ReduceOp op, bits(N) input, bits(M) mask, bits(esize) identity)
    assert(N == M * 8);
    integer p2bits = CeilPow2(N);
    bits(p2bits) operand;
    integer elements = p2bits DIV esize;

    for e = 0 to elements-1
        if e * esize < N && ElemP[mask, e, esize] == '1' then
            Elem[operand, e, esize] = Elem[input, e, esize];
        else
            Elem[operand, e, esize] = identity;

    return Reduce(op, operand, esize);
```

Library pseudocode for aarch64/functions/sve/Reverse

```
// Reverse()
// =========
// Reverse subwords of M bits in an N-bit word

bits(N) Reverse(bits(N) word, integer M)
    bits(N) result;
    integer sw = N DIV M;
    assert N == sw * M;
    for s = 0 to sw-1
        Elem[result, sw - 1 - s, M] = Elem[word, s, M];
    return result;
```

Library pseudocode for aarch64/functions/sve/SVEAccessTrap

```
// SVEAccessTrap()
// ===============
// Trapped access to SVE registers due to CPACR_EL1, CPTR_EL2, or CPTR_EL3.

SVEAccessTrap(bits(2) target_el)
    assert UInt(target_el) >= UInt(PSTATE.EL) && target_el != EL0 && HaveEL(target_el);
    route_to_el2 = target_el == EL1 && EL2Enabled() && HCR_EL2.TGE == '1';

    exception = ExceptionSyndrome(Exception_SVEAccessTrap);
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    if route_to_el2 then
        AArch64.TakeException(EL2, exception, preferred_exception_return, vect_offset);
    else
        AArch64.TakeException(target_el, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/functions/sve/SVECmp

```
enumeration SVECmp { Cmp_EQ, Cmp_NE, Cmp_GE, Cmp_GT, Cmp_LT, Cmp_LE, Cmp_UN };
```

Library pseudocode for aarch64/functions/sve/SVEMoveMaskPreferred

```
// SVEMoveMaskPreferred()
// ======================
// Return FALSE if a bitmask immediate encoding would generate an immediate
// value that could also be represented by a single DUP instruction.
// Used as a condition for the preferred MOV<-DUPM alias.

boolean SVEMoveMaskPreferred(bits(13) imm13)
    bits(64) imm;
    (imm, -) = DecodeBitMasks(imm13<12>, imm13<5:0>, imm13<11:6>, TRUE);

    // Check for 8 bit immediates
    if !IsZero(imm<7:0>) then
        // Check for 'ffffffffffffffxy' or '00000000000000xy'
        if IsZero(imm<63:7>) || IsOnes(imm<63:7>) then
            return FALSE;

        // Check for 'ffffffxyffffffxy' or '000000xy000000xy'
        if imm<63:32> == imm<31:0> && (IsZero(imm<31:7>) || IsOnes(imm<31:7>)) then
            return FALSE;

        // Check for 'ffxyffxyffxyffxy' or '00xy00xy00xy00xy'
        if imm<63:32> == imm<31:0> && imm<31:16> == imm<15:0> && (IsZero(imm<15:7>) || IsOnes(imm<15:7>))
            return FALSE;

        // Check for 'xyxyxyxyxyxyxyxy'
        if imm<63:32> == imm<31:0> && imm<31:16> == imm<15:0> && (imm<15:8> == imm<7:0>) then
            return FALSE;

    // Check for 16 bit immediates
    else
        // Check for 'ffffffffffffxy00' or '000000000000xy00'
        if IsZero(imm<63:15>) || IsOnes(imm<63:15>) then
            return FALSE;

        // Check for 'ffffxy00ffffxy00' or '0000xy000000xy00'
        if imm<63:32> == imm<31:0> && (IsZero(imm<31:7>) || IsOnes(imm<31:7>)) then
            return FALSE;

        // Check for 'xy00xy00xy00xy00'
        if imm<63:32> == imm<31:0> && imm<31:16> == imm<15:0> then
            return FALSE;

    return TRUE;
```

Library pseudocode for aarch64/functions/sve/ShiftSat

```
// ShiftSat()
// ==========

integer ShiftSat(integer shift, integer esize)
    if shift > esize+1 then return esize+1;
    elsif shift < -(esize+1) then return -(esize+1);
    return shift;
```

Library pseudocode for aarch64/functions/sve/System

```
array bits(MAX_VL) _Z[0..31];
array bits(MAX_PL) _P[0..15];
bits(MAX_PL) _FFR;
```

Library pseudocode for aarch64/functions/sve/VL

```
// VL - non-assignment form
// =======================

integer VL
    integer vl;

    if PSTATE.EL == EL1 || (PSTATE.EL == EL0 && !IsInHost()) then
        vl = UInt(ZCR_EL1.LEN);

    if PSTATE.EL == EL2 || (PSTATE.EL == EL0 && IsInHost()) then
        vl = UInt(ZCR_EL2.LEN);
    elsif PSTATE.EL IN {EL0, EL1} && EL2Enabled() then
        vl = Min(vl, UInt(ZCR_EL2.LEN));

    if PSTATE.EL == EL3 then
        vl = UInt(ZCR_EL3.LEN);
    elsif HaveEL(EL3) then
        vl = Min(vl, UInt(ZCR_EL3.LEN));

    vl = (vl + 1) * 128;
    vl = ImplementedSVEVectorLength(vl);

    return vl;
```

Library pseudocode for aarch64/functions/sve/Z

```
// Z[] - non-assignment form
// =========================

bits(width) Z[integer n]
    assert n >= 0 && n <= 31;
    assert width == VL;
    return _Z[n]<width-1:0>;

// Z[] - assignment form
// =====================

Z[integer n] = bits(width) value
    assert n >= 0 && n <= 31;
    assert width == VL;
    if ConstrainUnpredictableBool(Unpredictable_SVEZEROUPPER) then
        _Z[n] = ZeroExtend(value);
    else
        _Z[n]<width-1:0> = value;
```

Library pseudocode for aarch64/functions/sysregisters/CNTKCTL

```
// CNTKCTL[] - non-assignment form
// ===============================

CNTKCTLType CNTKCTL[]
    bits(32) r;
    if IsInHost() then
        r = CNTHCTL_EL2;
        return r;
    r = CNTKCTL_EL1;
    return r;
```

Library pseudocode for aarch64/functions/sysregisters/CNTKCTLType

```
type CNTKCTLType;
```

Library pseudocode for aarch64/functions/sysregisters/CPACR

```
// CPACR[] - non-assignment form
// =============================

CPACRType CPACR[]
    bits(32) r;
    if IsInHost() then
        r = CPTR_EL2;
        return r;
    r = CPACR_EL1;
    return r;
```

Library pseudocode for aarch64/functions/sysregisters/CPACRType

```
type CPACRType;
```

Library pseudocode for aarch64/functions/sysregisters/ELR

```
// ELR[] - non-assignment form
// ===========================

bits(64) ELR[bits(2) el]
    bits(64) r;
    case el of
        when EL1  r = ELR_EL1;
        when EL2  r = ELR_EL2;
        when EL3  r = ELR_EL3;
        otherwise Unreachable();
    return r;

// ELR[] - non-assignment form
// ===========================

bits(64) ELR[]
    assert PSTATE.EL != EL0;
    return ELR[PSTATE.EL];

// ELR[] - assignment form
// =======================

ELR[bits(2) el] = bits(64) value
    bits(64) r = value;
    case el of
        when EL1  ELR_EL1 = r;
        when EL2  ELR_EL2 = r;
        when EL3  ELR_EL3 = r;
        otherwise Unreachable();
    return;

// ELR[] - assignment form
// =======================

ELR[] = bits(64) value
    assert PSTATE.EL != EL0;
    ELR[PSTATE.EL] = value;
    return;
```

Library pseudocode for aarch64/functions/sysregisters/ESR

```
// ESR[] - non-assignment form
// ===========================

ESRType ESR[bits(2) regime]
    bits(32) r;
    case regime of
        when EL1  r = ESR_EL1;
        when EL2  r = ESR_EL2;
        when EL3  r = ESR_EL3;
        otherwise Unreachable();
    return r;

// ESR[] - non-assignment form
// ===========================

ESRType ESR[]
    return ESR[S1TranslationRegime()];

// ESR[] - assignment form
// =======================

ESR[bits(2) regime] = ESRType value
    bits(32) r = value;
    case regime of
        when EL1  ESR_EL1 = r;
        when EL2  ESR_EL2 = r;
        when EL3  ESR_EL3 = r;
        otherwise Unreachable();
    return;

// ESR[] - assignment form
// =======================

ESR[] = ESRType value
    ESR[S1TranslationRegime()] = value;
```

Library pseudocode for aarch64/functions/sysregisters/ESRType

```
type ESRType;
```

Library pseudocode for aarch64/functions/sysregisters/FAR

```
// FAR[] - non-assignment form
// ===========================

bits(64) FAR[bits(2) regime]
    bits(64) r;
    case regime of
        when EL1  r = FAR_EL1;
        when EL2  r = FAR_EL2;
        when EL3  r = FAR_EL3;
        otherwise Unreachable();
    return r;

// FAR[] - non-assignment form
// ===========================

bits(64) FAR[]
    return FAR[S1TranslationRegime()];

// FAR[] - assignment form
// =======================

FAR[bits(2) regime] = bits(64) value
    bits(64) r = value;
    case regime of
        when EL1  FAR_EL1 = r;
        when EL2  FAR_EL2 = r;
        when EL3  FAR_EL3 = r;
        otherwise Unreachable();
    return;

// FAR[] - assignment form
// =======================

FAR[] = bits(64) value
    FAR[S1TranslationRegime()] = value;
    return;
```

Library pseudocode for aarch64/functions/sysregisters/MAIR

```
// MAIR[] - non-assignment form
// ============================

MAIRType MAIR[bits(2) regime]
    bits(64) r;
    case regime of
        when EL1  r = MAIR_EL1;
        when EL2  r = MAIR_EL2;
        when EL3  r = MAIR_EL3;
        otherwise Unreachable();
    return r;

// MAIR[] - non-assignment form
// ============================

MAIRType MAIR[]
    return MAIR[S1TranslationRegime()];
```

Library pseudocode for aarch64/functions/sysregisters/MAIRType

```
type MAIRType;
```

Library pseudocode for aarch64/functions/sysregisters/SCTLR

```
// SCTLR[] - non-assignment form
// ============================

SCTLRType SCTLR[bits(2) regime]
    bits(64) r;
    case regime of
        when EL1  r = SCTLR_EL1;
        when EL2  r = SCTLR_EL2;
        when EL3  r = SCTLR_EL3;
        otherwise Unreachable();
    return r;

// SCTLR[] - non-assignment form
// ============================

SCTLRType SCTLR[]
    return SCTLR[S1TranslationRegime()];
```

Library pseudocode for aarch64/functions/sysregisters/SCTLRType

```
type SCTLRType;
```

Library pseudocode for aarch64/functions/sysregisters/VBAR

```
// VBAR[] - non-assignment form
// ============================

bits(64) VBAR[bits(2) regime]
    bits(64) r;
    case regime of
        when EL1  r = VBAR_EL1;
        when EL2  r = VBAR_EL2;
        when EL3  r = VBAR_EL3;
        otherwise Unreachable();
    return r;

// VBAR[] - non-assignment form
// ============================

bits(64) VBAR[]
    return VBAR[S1TranslationRegime()];
```

Library pseudocode for aarch64/functions/system/AArch64.AllocationTagAccessIsEnabled

```
// AArch64.AllocationTagAccessIsEnabled()
// ======================================
// Check whether access to Allocation Tags is enabled.

boolean AArch64.AllocationTagAccessIsEnabled()
    if SCR_EL3.ATA == '0' && PSTATE.EL IN {EL0, EL1, EL2} then
        return FALSE;
    elsif HCR_EL2.ATA == '0' && PSTATE.EL IN {EL0, EL1} && EL2Enabled() && HCR_EL2.<E2H,TGE> != '11' then
        return FALSE;
    elsif SCTLR_EL3.ATA == '0' && PSTATE.EL == EL3 then
        return FALSE;
    elsif SCTLR_EL2.ATA == '0' && PSTATE.EL == EL2 then
        return FALSE;
    elsif SCTLR_EL1.ATA == '0' && PSTATE.EL == EL1 then
        return FALSE;
    elsif SCTLR_EL2.ATA0 == '0' && PSTATE.EL == EL0 && EL2Enabled() && HCR_EL2.<E2H,TGE> == '11' then
        return FALSE;
    elsif SCTLR_EL1.ATA0 == '0' && PSTATE.EL == EL0 && !(EL2Enabled() && HCR_EL2.<E2H,TGE> == '11') then
        return FALSE;
    else
        return TRUE;
```

Library pseudocode for aarch64/functions/system/AArch64.CheckSystemAccess

```
// AArch64.CheckSystemAccess()
// ===========================
// Checks if an AArch64 MSR, MRS or SYS instruction is allowed from the current exception level and secur
// Also checks for traps by TIDCP and NV access.

AArch64.CheckSystemAccess(bits(2) op0, bits(3) op1, bits(4) crn, bits(4) crm, bits(3) op2, bits(5) rt, bi
    boolean unallocated = FALSE;
    boolean need_secure = FALSE;
    bits(2) min_EL;

    if TSTATE.depth > 0 && !CheckTransactionalSystemAccess(op0, op1, crn, crm, op2, read) then
        FailTransaction(TMFailure_ERR, FALSE);

    // Check for traps by HCR_EL2.TIDCP
    if PSTATE.EL IN {EL0, EL1} && EL2Enabled() && HCR_EL2.TIDCP == '1' && op0 == 'x1' && crn == '1x11' th
        // At EL0, it is IMPLEMENTATION_DEFINED whether attempts to execute system
        // register access instructions with reserved encodings are trapped to EL2 or UNDEFINED
        rcs_el0_trap = boolean IMPLEMENTATION_DEFINED "Reserved Control Space EL0 Trapped";
        if PSTATE.EL == EL1 || rcs_el0_trap then
            AArch64.SystemAccessTrap(EL2, 0x18);    // Exception_SystemRegisterTrap

    // Check for unallocated encodings
    case op1 of
        when '00x', '010'
            min_EL = EL1;
        when '011'
            min_EL = EL0;
        when '100'
            min_EL = EL2;
        when '101'
            if !HaveVirtHostExt() then UNDEFINED;
            min_EL = EL2;
        when '110'
            min_EL = EL3;
        when '111'
            min_EL = EL1;
            need_secure = TRUE;

    if UInt(PSTATE.EL) < UInt(min_EL) then
        // Check for traps on read/write access to registers named _EL2, _EL02, _EL12 from non-secure EL1
        nv_access = HaveNVExt() && min_EL == EL2 && PSTATE.EL == EL1 && EL2Enabled() && HCR_EL2.NV == '1'
        if !nv_access then
            UNDEFINED;
    elsif need_secure && !IsSecure() then
        UNDEFINED;
```

Library pseudocode for aarch64/functions/system/AArch64.ChooseNonExcludedTag

```
// AArch64.ChooseNonExcludedTag()
// ==============================
// Return a tag derived from the start and the offset values, excluding
// any tags in the given mask.

bits(4) AArch64.ChooseNonExcludedTag(bits(4) tag, bits(4) offset, bits(16) exclude)
    if IsOnes(exclude) then
        return '0000';

    if offset == '0000' then
        while exclude<UInt(tag)> == '1' do
            tag = tag + '0001';

    while offset != '0000' do
        offset = offset - '0001';
        tag = tag + '0001';
        while exclude<UInt(tag)> == '1' do
            tag = tag + '0001';

    return tag;
```

Library pseudocode for aarch64/functions/system/AArch64.ExecutingATS1xPInstr

```
// AArch64.ExecutingATS1xPInstr()
// ==============================
// Return TRUE if current instruction is AT S1E1R/WP

boolean AArch64.ExecutingATS1xPInstr()
    if !HavePrivATExt() then return FALSE;

    instr = ThisInstr();
    if instr<22+:10> == '1101010100' then
        op1  = instr<16+:3>;
        CRn  = instr<12+:4>;
        CRm  = instr<8+:4>;
        op2  = instr<5+:3>;
        return op1 == '000' && CRn == '0111' && CRm == '1001' && op2 IN {'000','001'};
    else
        return FALSE;
```

Library pseudocode for aarch64/functions/system/AArch64.ExecutingBROrBLROrRetInstr

```
// AArch64.ExecutingBROrBLROrRetInstr()
// ====================================
// Returns TRUE if current instruction is a BR, BLR, RET, B[L]RA[B][Z], or RETA[B].

boolean AArch64.ExecutingBROrBLROrRetInstr()
    if !HaveBTIExt() then return FALSE;

    instr = ThisInstr();
    if instr<31:25> == '1101011' && instr<20:16> == '11111' then
        opc = instr<24:21>;
        return opc != '0101';
    else
        return FALSE;
```

Library pseudocode for aarch64/functions/system/AArch64.ExecutingBTIInstr

```
// AArch64.ExecutingBTIInstr()
// ===========================
// Returns TRUE if current instruction is a BTI.

boolean AArch64.ExecutingBTIInstr()
    if !HaveBTIExt() then return FALSE;

    instr = ThisInstr();
    if instr<31:22> == '1101010100' && instr<21:12> == '0000110010' && instr<4:0> == '11111' then
        CRm  = instr<11:8>;
        op2  = instr<7:5>;
        return (CRm == '0100' && op2<0> == '0');
    else
        return FALSE;
```

Library pseudocode for aarch64/functions/system/AArch64.ExecutingERETInstr

```
// AArch64.ExecutingERETInstr()
// ============================
// Returns TRUE if current instruction is ERET.

boolean AArch64.ExecutingERETInstr()
    instr = ThisInstr();
    return instr<31:12> == '11010110100111110000';
```

Library pseudocode for aarch64/functions/system/AArch64.NextRandomTagBit

```
// AArch64.NextRandomTagBit()
// ==========================
// Generate a random bit suitable for generating a random Allocation Tag.

bit AArch64.NextRandomTagBit()
    bits(16) lfsr = RGSR_EL1.SEED;
    bit top = lfsr<5> EOR lfsr<3> EOR lfsr<2> EOR lfsr<0>;
    RGSR_EL1.SEED = top:lfsr<15:1>;
    return top;
```

Library pseudocode for aarch64/functions/system/AArch64.RandomTag

```
// AArch64.RandomTag()
// ===================
// Generate a random Allocation Tag.

bits(4) AArch64.RandomTag()
    bits(4) tag;
    for i = 0 to 3
        tag<i> = AArch64.NextRandomTagBit();
    return tag;
```

Library pseudocode for aarch64/functions/system/AArch64.SysInstr

```
// Execute a system instruction with write (source operand).
AArch64.SysInstr(integer op0, integer op1, integer crn, integer crm, integer op2, bits(64) val);
```

Library pseudocode for aarch64/functions/system/AArch64.SysInstrWithResult

```
// Execute a system instruction with read (result operand).
// Returns the result of the instruction.
bits(64) AArch64.SysInstrWithResult(integer op0, integer op1, integer crn, integer crm, integer op2);
```

Library pseudocode for aarch64/functions/system/AArch64.SysRegRead

```
// Read from a system register and return the contents of the register.
bits(64) AArch64.SysRegRead(integer op0, integer op1, integer crn, integer crm, integer op2);
```

Library pseudocode for aarch64/functions/system/AArch64.SysRegWrite

```
// Write to a system register.
AArch64.SysRegWrite(integer op0, integer op1, integer crn, integer crm, integer op2, bits(64) val);
```

Library pseudocode for aarch64/functions/system/BTypeCompatible

```
boolean BTypeCompatible;
```

Library pseudocode for aarch64/functions/system/BTypeCompatible_BTI

```
// BTypeCompatible_BTI
// ===================
// This function determines whether a given hint encoding is compatible with the current value of
// PSTATE.BTYPE. A value of TRUE here indicates a valid Branch Target Identification instruction.

boolean BTypeCompatible_BTI(bits(2) hintcode)
    case hintcode of
        when '00'
            return FALSE;
        when '01'
            return PSTATE.BTYPE != '11';
        when '10'
            return PSTATE.BTYPE != '10';
        when '11'
            return TRUE;
```

Library pseudocode for aarch64/functions/system/BTypeCompatible_PACIXSP

```
// BTypeCompatible_PACIXSP()
// =========================
// Returns TRUE if PACIASP, PACIBSP instruction is implicit compatible with PSTATE.BTYPE,
// FALSE otherwise.

boolean BTypeCompatible_PACIXSP()
    if PSTATE.BTYPE IN {'01', '10'} then
        return TRUE;
    elsif PSTATE.BTYPE == '11' then
        index = if PSTATE.EL == EL0 then 35 else 36;
        return SCTLR[]<index> == '0';
    else
        return FALSE;
```

Library pseudocode for aarch64/functions/system/BTypeNext

```
bits(2) BTypeNext;
```

Library pseudocode for aarch64/functions/system/InGuardedPage

```
boolean InGuardedPage;
```

Library pseudocode for aarch64/functions/tme/CheckTMEEnabled

```
// CheckTMEEnabled()
// =================
// Returns TRUE if access to TME instruction is enabled, FALSE otherwise.

CheckTMEEnabled()
    if PSTATE.EL IN {EL0, EL1, EL2} && HaveEL(EL3) then
        if SCR_EL3.TME == '0' then UNDEFINED;
    if PSTATE.EL IN {EL0, EL1} && EL2Enabled() then
        if HCR_EL2.TME == '0' then UNDEFINED;
    return;
```

Library pseudocode for aarch64/functions/tme/CheckTransactionalSystemAccess

```
// CheckTransactionalSystemAccess()
// ================================
// Returns TRUE if an AArch64 MSR, MRS, or SYS instruction is permitted in
// Transactional state, based on the opcode's encoding, and FALSE otherwise.

boolean CheckTransactionalSystemAccess(bits(2) op0, bits(3) op1, bits(4) crn, bits(4) crm, bits(3) op2, b
    case read:op0:op1:crn:crm:op2 of
        when '0 00 011 0100 xxxx 11x' return TRUE;      // MSR (imm): DAIFSet, DAIFClr
        when '0 01 011 0111 0100 001' return TRUE;      // DC ZVA
        when '0 11 011 0100 0010 00x' return TRUE;      // MSR: NZCV, DAIF
        when '0 11 011 0100 0100 00x' return TRUE;      // MSR: FPCR, FPSR
        when '0 11 000 0100 0110 000' return TRUE;      // MSR: ICC_PMR_EL1
        when '0 11 011 1001 1100 100' return TRUE;      // MRS: PMSWINC_EL0
        when '1 11 xxx 0xxx xxxx xxx' return TRUE;      // MRS: op1=3, CRn=0..7
        when '1 11 xxx 100x xxxx xxx' return TRUE;      // MRS: op1=3, CRn=8..9
        when '1 11 xxx 1010 xxxx xxx' return TRUE;      // MRS: op1=3, CRn=10
        when '1 11 000 1100 1x00 010' return TRUE;      // MRS: op1=3, CRn=12 - ICC_HPPIRx_EL1
        when '1 11 000 1100 1011 011' return TRUE;      // MRS: op1=3, CRn=12 - ICC_RPR_EL1
        when '1 11 xxx 1101 xxxx xxx' return TRUE;      // MRS: op1=3, CRn=13
        when '1 11 xxx 1110 xxxx xxx' return TRUE;      // MRS: op1=3, CRn=14
        when 'x 11 xxx 1x11 xxxx xxx' return boolean IMPLEMENTATION_DEFINED; // MRS: op1=3, CRn=11,15
        otherwise return FALSE;                         // all other SYS, SYSL, MRS, MSR
```

Library pseudocode for aarch64/functions/tme/CommitTransactionalWrites

```
// Makes all transactional writes to memory observable by other PEs and reset
// the transactional read and write sets.
CommitTransactionalWrites();
```

Library pseudocode for aarch64/functions/tme/DiscardTransactionalWrites

```
// Discards all transactional writes to memory and reset the transactional
// read and write sets.
DiscardTransactionalWrites();
```

Library pseudocode for aarch64/functions/tme/FailTransaction

```
// FailTransaction()
// =================

FailTransaction(TMFailure cause, boolean retry)
    FailTransaction(cause, retry, FALSE, Zeros(15));
    return;

// FailTransaction()
// =================
// Exits Transactional state and discards transactional updates to registers
// and memory.

FailTransaction(TMFailure cause, boolean retry, boolean interrupt, bits(15) reason)
    assert !retry || !interrupt;

    DiscardTransactionalWrites();
    RestoreTransactionCheckpoint();
    ClearExclusiveLocal(ProcessorID());

    bits(64) result = Zeros();

    result<23> = if interrupt then '1' else '0';
    result<15> = if retry && !interrupt then '1' else '0';
    case cause of
        when TMFailure_DBG  result<22> = '1';
        when TMFailure_NEST result<21> = '1';
        when TMFailure_SIZE result<20> = '1';
        when TMFailure_ERR  result<19> = '1';
        when TMFailure_IMP  result<18> = '1';
        when TMFailure_MEM  result<17> = '1';
        when TMFailure_CNCL result<16> = '1'; result<14:0> = reason;

    TSTATE.depth = 0;
    X[TSTATE.Rt] = result;
    BranchTo(TSTATE.nPC, BranchType_TMFAIL);
    EndOfInstruction();
    return;
```

Library pseudocode for aarch64/functions/tme/RestoreTransactionCheckpoint

```
// RestoreTransactionCheckpoint()
// ==============================
// Restores part of the PE registers from the transaction checkpoint.

RestoreTransactionCheckpoint()
    SP[]              = TSTATE.SP;
    ICC_PMR_EL1       = TSTATE.ICC_PMR_EL1;
    PSTATE.<N,Z,C,V> = TSTATE.nzcv;
    PSTATE.<D,A,I,F> = TSTATE.<D,A,I,F>;

    for n = 0 to 30
        X[n] = TSTATE.X[n];

    if IsFPEnabled(PSTATE.EL) then
        if IsSVEEnabled(PSTATE.EL) then
            for n = 0 to 31
                Z[n] = TSTATE.Z[n]<VL-1:0>;
            for n = 0 to 15
                P[n] = TSTATE.P[n]<PL-1:0>;
            FFR[] = TSTATE.FFR<PL-1:0>;
        else
            for n = 0 to 31
                V[n] = TSTATE.Z[n]<127:0>;
        FPCR = TSTATE.FPCR;
        FPSR = TSTATE.FPSR;

    return;
```

Library pseudocode for aarch64/functions/tme/StartTrackingTransactionalReadsWrites

```
// Starts tracking transactional reads and writes to memory.
StartTrackingTransactionalReadsWrites();
```

Library pseudocode for aarch64/functions/tme/TMFailure

```
enumeration TMFailure {
    TMFailure_CNCL,    // Executed a TCANCEL instruction
    TMFailure_DBG,     // A debug event was generated
    TMFailure_ERR,     // A non-permissible operation was attempted
    TMFailure_NEST,    // The maximum transactional nesting level was exceeded
    TMFailure_SIZE,    // The transactional read or write set limit was exceeded
    TMFailure_MEM,     // A transactional conflict occurred
    TMFailure_TRIVIAL, // Only a TRIVIAL version of TM is available
    TMFailure_IMP      // Any other failure cause
};
```

Library pseudocode for aarch64/functions/tme/TMState

```
type TMState is (
    integer       depth,              // Transaction nesting depth
    integer       Rt,                 // TSTART destination register
    bits(64)      nPC,                // Fallback instruction address
    array[0..30] of bits(64)     X,   // General purpose registers
    array[0..31] of bits(MAX_VL) Z,   // Vector registers
    array[0..15] of bits(MAX_PL) P,   // Predicate registers
    bits(MAX_PL)  FFR,                // First Fault Register
    bits(64)      SP,                 // Stack Pointer at current EL
    bits(32)      FPCR,               // Floating-point Control Register
    bits(32)      FPSR,               // Floating-point Status Register
    bits(32)      ICC_PMR_EL1,        // Interrupt Controller Interrupt Priority Mask Register
    bits(4)       nzcv,               // Condition flags
    bits(1)       D,                  // Debug mask bit
    bits(1)       A,                  // SError interrupt mask bit
    bits(1)       I,                  // IRQ mask bit
    bits(1)       F                   // FIQ mask bit
)
```

Library pseudocode for aarch64/functions/tme/TSTATE

```
TMState TSTATE;
```

Library pseudocode for aarch64/functions/tme/TakeTransactionCheckpoint

```
// TakeTransactionCheckpoint()
// ===========================
// Captures part of the PE registers into the transaction checkpoint.

TakeTransactionCheckpoint()
    TSTATE.SP          = SP[];
    TSTATE.ICC_PMR_EL1 = ICC_PMR_EL1;
    TSTATE.nzcv        = PSTATE.<N,Z,C,V>;
    TSTATE.<D,A,I,F>   = PSTATE.<D,A,I,F>;

    for n = 0 to 30
        TSTATE.X[n] = X[n];

    if IsFPEnabled(PSTATE.EL) then
        if IsSVEEnabled(PSTATE.EL) then
            for n = 0 to 31
                TSTATE.Z[n]<VL-1:0> = Z[n];
            for n = 0 to 15
                TSTATE.P[n]<PL-1:0> = P[n];
            TSTATE.FFR<PL-1:0> = FFR[];
        else
            for n = 0 to 31
                TSTATE.Z[n]<127:0> = V[n];
        TSTATE.FPCR = FPCR;
        TSTATE.FPSR = FPSR;

    return;
```

Library pseudocode for aarch64/functions/tme/TransactionStartTrap

```
// TransactionStartTrap()
// ======================
// Traps the execution of TSTART instruction.

TransactionStartTrap(integer dreg)
    bits(64) preferred_exception_return = ThisInstrAddr();
    vect_offset = 0x0;

    exception = ExceptionSyndrome(Exception_TSTARTAccessTrap);
    exception.syndrome<9:5> = dreg<4:0>;

    if UInt(PSTATE.EL) > UInt(EL1) then
        targetEL = PSTATE.EL;
    elsif EL2Enabled() && HCR_EL2.TGE == '1' then
        targetEL = EL2;
    else
        targetEL = EL1;
    AArch64.TakeException(targetEL, exception, preferred_exception_return, vect_offset);
```

Library pseudocode for aarch64/instrs/branch/eret/AArch64.ExceptionReturn

```
// AArch64.ExceptionReturn()
// =========================

AArch64.ExceptionReturn(bits(64) new_pc, bits(32) spsr)

    if TSTATE.depth > 0 then
        FailTransaction(TMFailure_ERR, FALSE);

    SynchronizeContext();

    sync_errors = HaveIESB() && SCTLR[].IESB == '1';
    if HaveDoubleFaultExt() then
        sync_errors = sync_errors || (SCR_EL3.EA == '1' && SCR_EL3.NMEA == '1' && PSTATE.EL == EL3);
    if sync_errors then
        SynchronizeErrors();
        iesb_req = TRUE;
        TakeUnmaskedPhysicalSErrorInterrupts(iesb_req);
    // Attempts to change to an illegal state will invoke the Illegal Execution state mechanism
    SetPSTATEFromPSR(spsr);
    ClearExclusiveLocal(ProcessorID());
    SendEventLocal();

    if PSTATE.IL == '1' && spsr<4> == '1' && spsr<20> == '0' then
        // If the exception return is illegal, PC[63:32,1:0] are UNKNOWN
        new_pc<63:32> = bits(32) UNKNOWN;
        new_pc<1:0> = bits(2) UNKNOWN;
    elsif UsingAArch32() then                // Return to AArch32
        // ELR_ELx[1:0] or ELR_ELx[0] are treated as being 0, depending on the target instruction set sta
        if PSTATE.T == '1' then
            new_pc<0> = '0';                 // T32
        else
            new_pc<1:0> = '00';              // A32
    else                                     // Return to AArch64
        // ELR_ELx[63:56] might include a tag
        new_pc = AArch64.BranchAddr(new_pc);

    if UsingAArch32() then
        // 32 most significant bits are ignored.
        BranchTo(new_pc<31:0>, BranchType_ERET);
    else
        BranchToAddr(new_pc, BranchType_ERET);
```

Library pseudocode for aarch64/instrs/countop/CountOp

```
enumeration CountOp     {CountOp_CLZ, CountOp_CLS, CountOp_CNT};
```

Library pseudocode for aarch64/instrs/extendreg/DecodeRegExtend

```
// DecodeRegExtend()
// =================
// Decode a register extension option

ExtendType DecodeRegExtend(bits(3) op)
    case op of
        when '000' return ExtendType_UXTB;
        when '001' return ExtendType_UXTH;
        when '010' return ExtendType_UXTW;
        when '011' return ExtendType_UXTX;
        when '100' return ExtendType_SXTB;
        when '101' return ExtendType_SXTH;
        when '110' return ExtendType_SXTW;
        when '111' return ExtendType_SXTX;
```

Library pseudocode for aarch64/instrs/extendreg/ExtendReg

```
// ExtendReg()
// ===========
// Perform a register extension and shift

bits(N) ExtendReg(integer reg, ExtendType exttype, integer shift)
    assert shift >= 0 && shift <= 4;
    bits(N) val = X[reg];
    boolean unsigned;
    integer len;

    case exttype of
        when ExtendType_SXTB unsigned = FALSE; len = 8;
        when ExtendType_SXTH unsigned = FALSE; len = 16;
        when ExtendType_SXTW unsigned = FALSE; len = 32;
        when ExtendType_SXTX unsigned = FALSE; len = 64;
        when ExtendType_UXTB unsigned = TRUE;  len = 8;
        when ExtendType_UXTH unsigned = TRUE;  len = 16;
        when ExtendType_UXTW unsigned = TRUE;  len = 32;
        when ExtendType_UXTX unsigned = TRUE;  len = 64;

    // Note the extended width of the intermediate value and
    // that sign extension occurs from bit <len+shift-1>, not
    // from bit <len-1>. This is equivalent to the instruction
    //   [SU]BFIZ Rtmp, Rreg, #shift, #len
    // It may also be seen as a sign/zero extend followed by a shift:
    //   LSL(Extend(val<len-1:0>, N, unsigned), shift);

    len = Min(len, N - shift);
    return Extend(val<len-1:0> : Zeros(shift), N, unsigned);
```

Library pseudocode for aarch64/instrs/extendreg/ExtendType

```
enumeration ExtendType  {ExtendType_SXTB, ExtendType_SXTH, ExtendType_SXTW, ExtendType_SXTX,
                         ExtendType_UXTB, ExtendType_UXTH, ExtendType_UXTW, ExtendType_UXTX};
```

Library pseudocode for aarch64/instrs/float/arithmetic/max-min/fpmaxminop/FPMaxMinOp

```
enumeration FPMaxMinOp  {FPMaxMinOp_MAX, FPMaxMinOp_MIN,
                         FPMaxMinOp_MAXNUM, FPMaxMinOp_MINNUM};
```

Library pseudocode for aarch64/instrs/float/arithmetic/unary/fpunaryop/FPUnaryOp

```
enumeration FPUnaryOp   {FPUnaryOp_ABS, FPUnaryOp_MOV,
                         FPUnaryOp_NEG, FPUnaryOp_SQRT};
```

Library pseudocode for aarch64/instrs/float/convert/fpconvop/FPConvOp

```
enumeration FPConvOp    {FPConvOp_CVT_FtoI, FPConvOp_CVT_ItoF,
                         FPConvOp_MOV_FtoI, FPConvOp_MOV_ItoF
                         , FPConvOp_CVT_FtoI_JS
};
```

Library pseudocode for aarch64/instrs/integer/bitfield/bfxpreferred/BFXPreferred

```
// BFXPreferred()
// ==============
//
// Return TRUE if UBFX or SBFX is the preferred disassembly of a
// UBFM or SBFM bitfield instruction. Must exclude more specific
// aliases UBFIZ, SBFIZ, UXT[BH], SXT[BHW], LSL, LSR and ASR.

boolean BFXPreferred(bit sf, bit uns, bits(6) imms, bits(6) immr)
    integer S = UInt(imms);
    integer R = UInt(immr);

    // must not match UBFIZ/SBFIX alias
    if UInt(imms) < UInt(immr) then
        return FALSE;

    // must not match LSR/ASR/LSL alias (imms == 31 or 63)
    if imms == sf:'11111' then
        return FALSE;

    // must not match UXTx/SXTx alias
    if immr == '000000' then
        // must not match 32-bit UXT[BH] or SXT[BH]
        if sf == '0' && imms IN {'000111', '001111'} then
            return FALSE;
        // must not match 64-bit SXT[BHW]
        if sf:uns == '10' && imms IN {'000111', '001111', '011111'} then
            return FALSE;

    // must be UBFX/SBFX alias
    return TRUE;
```

Library pseudocode for aarch64/instrs/integer/bitmasks/DecodeBitMasks

```
// DecodeBitMasks()
// ================

// Decode AArch64 bitfield and logical immediate masks which use a similar encoding structure

(bits(M), bits(M)) DecodeBitMasks(bit immN, bits(6) imms, bits(6) immr, boolean immediate)
    bits(64) tmask, wmask;
    bits(6) tmask_and, wmask_and;
    bits(6) tmask_or, wmask_or;
    bits(6) levels;

    // Compute log2 of element size
    // 2^len must be in range [2, M]
    len = HighestSetBit(immN:NOT(imms));
    if len < 1 then UNDEFINED;
    assert M >= (1 << len);

    // Determine S, R and S - R parameters
    levels = ZeroExtend(Ones(len), 6);

    // For logical immediates an all-ones value of S is reserved
    // since it would generate a useless all-ones result (many times)
    if immediate && (imms AND levels) == levels then
        UNDEFINED;

    S = UInt(imms AND levels);
    R = UInt(immr AND levels);
    diff = S - R;    // 6-bit subtract with borrow

    // From a software perspective, the remaining code is equivalant to:
    //   esize = 1 << len;
    //   d = UInt(diff<len-1:0>);
    //   welem = ZeroExtend(Ones(S + 1), esize);
    //   telem = ZeroExtend(Ones(d + 1), esize);
    //   wmask = Replicate(ROR(welem, R));
    //   tmask = Replicate(telem);
    //   return (wmask, tmask);

    // Compute "top mask"
    tmask_and = diff<5:0> OR NOT(levels);
    tmask_or  = diff<5:0> AND levels;

    tmask = Ones(64);
    tmask = ((tmask
              AND Replicate(Replicate(tmask_and<0>, 1) : Ones(1), 32))
               OR  Replicate(Zeros(1) : Replicate(tmask_or<0>, 1), 32));
    // optimization of first step:
    // tmask = Replicate(tmask_and<0> : '1', 32);
    tmask = ((tmask
              AND Replicate(Replicate(tmask_and<1>, 2) : Ones(2), 16))
               OR  Replicate(Zeros(2) : Replicate(tmask_or<1>, 2), 16));
    tmask = ((tmask
              AND Replicate(Replicate(tmask_and<2>, 4) : Ones(4), 8))
               OR  Replicate(Zeros(4) : Replicate(tmask_or<2>, 4), 8));
    tmask = ((tmask
              AND Replicate(Replicate(tmask_and<3>, 8) : Ones(8), 4))
               OR  Replicate(Zeros(8) : Replicate(tmask_or<3>, 8), 4));
    tmask = ((tmask
              AND Replicate(Replicate(tmask_and<4>, 16) : Ones(16), 2))
               OR  Replicate(Zeros(16) : Replicate(tmask_or<4>, 16), 2));
    tmask = ((tmask
              AND Replicate(Replicate(tmask_and<5>, 32) : Ones(32), 1))
               OR  Replicate(Zeros(32) : Replicate(tmask_or<5>, 32), 1));

    // Compute "wraparound mask"
    wmask_and = immr OR NOT(levels);
    wmask_or  = immr AND levels;

    wmask = Zeros(64);
    wmask = ((wmask
```

```
            AND Replicate(Ones(1) : Replicate(wmask_and<0>, 1), 32))
             OR  Replicate(Replicate(wmask_or<0>, 1) : Zeros(1), 32));
    // optimization of first step:
    // wmask = Replicate(wmask_or<0> : '0', 32);
    wmask = ((wmask
              AND Replicate(Ones(2) : Replicate(wmask_and<1>, 2), 16))
               OR  Replicate(Replicate(wmask_or<1>, 2) : Zeros(2), 16));
    wmask = ((wmask
              AND Replicate(Ones(4) : Replicate(wmask_and<2>, 4), 8))
               OR  Replicate(Replicate(wmask_or<2>, 4) : Zeros(4), 8));
    wmask = ((wmask
              AND Replicate(Ones(8) : Replicate(wmask_and<3>, 8), 4))
               OR  Replicate(Replicate(wmask_or<3>, 8) : Zeros(8), 4));
    wmask = ((wmask
              AND Replicate(Ones(16) : Replicate(wmask_and<4>, 16), 2))
               OR  Replicate(Replicate(wmask_or<4>, 16) : Zeros(16), 2));
    wmask = ((wmask
              AND Replicate(Ones(32) : Replicate(wmask_and<5>, 32), 1))
               OR  Replicate(Replicate(wmask_or<5>, 32) : Zeros(32), 1));

    if diff<6> != '0' then // borrow from S - R
        wmask = wmask AND tmask;
    else
        wmask = wmask OR tmask;

    return (wmask<M-1:0>, tmask<M-1:0>);
```

Library pseudocode for aarch64/instrs/integer/ins-ext/insert/movewide/movewideop/MoveWideOp

```
enumeration MoveWideOp  {MoveWideOp_N, MoveWideOp_Z, MoveWideOp_K};
```

Library pseudocode for aarch64/instrs/integer/logical/movwpreferred/MoveWidePreferred

```
// MoveWidePreferred()
// ===================
//
// Return TRUE if a bitmask immediate encoding would generate an immediate
// value that could also be represented by a single MOVZ or MOVN instruction.
// Used as a condition for the preferred MOV<-ORR alias.

boolean MoveWidePreferred(bit sf, bit immN, bits(6) imms, bits(6) immr)
    integer S = UInt(imms);
    integer R = UInt(immr);
    integer width = if sf == '1' then 64 else 32;

    // element size must equal total immediate size
    if sf == '1' && immN:imms != '1xxxxxx' then
        return FALSE;
    if sf == '0' && immN:imms != '00xxxxx' then
        return FALSE;

    // for MOVZ must contain no more than 16 ones
    if S < 16 then
        // ones must not span halfword boundary when rotated
        return (-R MOD 16) <= (15 - S);

    // for MOVN must contain no more than 16 zeros
    if S >= width - 15 then
        // zeros must not span halfword boundary when rotated
        return (R MOD 16) <= (S - (width - 15));

    return FALSE;
```

Library pseudocode for aarch64/instrs/integer/shiftreg/DecodeShift

```
// DecodeShift()
// =============
// Decode shift encodings

ShiftType DecodeShift(bits(2) op)
    case op of
        when '00'  return ShiftType_LSL;
        when '01'  return ShiftType_LSR;
        when '10'  return ShiftType_ASR;
        when '11'  return ShiftType_ROR;
```

Library pseudocode for aarch64/instrs/integer/shiftreg/ShiftReg

```
// ShiftReg()
// ==========
// Perform shift of a register operand

bits(N) ShiftReg(integer reg, ShiftType shiftype, integer amount)
    bits(N) result = X[reg];
    case shiftype of
        when ShiftType_LSL result = LSL(result, amount);
        when ShiftType_LSR result = LSR(result, amount);
        when ShiftType_ASR result = ASR(result, amount);
        when ShiftType_ROR result = ROR(result, amount);
    return result;
```

Library pseudocode for aarch64/instrs/integer/shiftreg/ShiftType

```
enumeration ShiftType   {ShiftType_LSL, ShiftType_LSR, ShiftType_ASR, ShiftType_ROR};
```

Library pseudocode for aarch64/instrs/logicalop/LogicalOp

```
enumeration LogicalOp   {LogicalOp_AND, LogicalOp_EOR, LogicalOp_ORR};
```

Library pseudocode for aarch64/instrs/memory/memop/MemAtomicOp

```
enumeration MemAtomicOp {MemAtomicOp_ADD,
                         MemAtomicOp_BIC,
                         MemAtomicOp_EOR,
                         MemAtomicOp_ORR,
                         MemAtomicOp_SMAX,
                         MemAtomicOp_SMIN,
                         MemAtomicOp_UMAX,
                         MemAtomicOp_UMIN,
                         MemAtomicOp_SWP};
```

Library pseudocode for aarch64/instrs/memory/memop/MemOp

```
enumeration MemOp {MemOp_LOAD, MemOp_STORE, MemOp_PREFETCH};
```

Library pseudocode for aarch64/instrs/memory/prefetch/Prefetch

```
// Prefetch()
// ==========

// Decode and execute the prefetch hint on ADDRESS specified by PRFOP

Prefetch(bits(64) address, bits(5) prfop)
    PrefetchHint hint;
    integer target;
    boolean stream;

    case prfop<4:3> of
        when '00' hint = Prefetch_READ;         // PLD: prefetch for load
        when '01' hint = Prefetch_EXEC;         // PLI: preload instructions
        when '10' hint = Prefetch_WRITE;        // PST: prepare for store
        when '11' return;                       // unallocated hint
    target = UInt(prfop<2:1>);                  // target cache level
    stream = (prfop<0> != '0');                 // streaming (non-temporal)
    Hint_Prefetch(address, hint, target, stream);
    return;
```

Library pseudocode for aarch64/instrs/system/barriers/barrierop/MemBarrierOp

```
enumeration MemBarrierOp   {  MemBarrierOp_DSB         // Data Synchronization Barrier
                           , MemBarrierOp_DMB         // Data Memory Barrier
                           , MemBarrierOp_ISB         // Instruction Synchronization Barrier
                           , MemBarrierOp_SSBB        // Speculative Synchronization Barrier to VA
                           , MemBarrierOp_PSSBB       // Speculative Synchronization Barrier to PA
                           , MemBarrierOp_SB          // Speculation Barrier
                           };
```

Library pseudocode for aarch64/instrs/system/hints/syshintop/SystemHintOp

```
enumeration SystemHintOp {
    SystemHintOp_NOP,
    SystemHintOp_YIELD,
    SystemHintOp_WFE,
    SystemHintOp_WFI,
    SystemHintOp_SEV,
    SystemHintOp_SEVL,
    SystemHintOp_ESB,
    SystemHintOp_PSB,
    SystemHintOp_TSB,
    SystemHintOp_BTI,
    SystemHintOp_CSDB
};
```

Library pseudocode for aarch64/instrs/system/register/cpsr/pstatefield/PSTATEField

```
enumeration PSTATEField {PSTATEField_DAIFSet, PSTATEField_DAIFClr,
                         PSTATEField_PAN, // Armv8.1
                         PSTATEField_UAO, // Armv8.2
                         PSTATEField_DIT, // Armv8.4
                         PSTATEField_SSBS,
                         PSTATEField_TCO, // Armv8.5
                         PSTATEField_SP
                         };
```

Library pseudocode for aarch64/instrs/system/sysops/sysop/SysOp

```
// SysOp()
// =======

SystemOp SysOp(bits(3) op1, bits(4) CRn, bits(4) CRm, bits(3) op2)
    case op1:CRn:CRm:op2 of
        when '000 0111 1000 000' return Sys_AT;   // S1E1R
        when '100 0111 1000 000' return Sys_AT;   // S1E2R
        when '110 0111 1000 000' return Sys_AT;   // S1E3R
        when '000 0111 1000 001' return Sys_AT;   // S1E1W
        when '100 0111 1000 001' return Sys_AT;   // S1E2W
        when '110 0111 1000 001' return Sys_AT;   // S1E3W
        when '000 0111 1000 010' return Sys_AT;   // S1E0R
        when '000 0111 1000 011' return Sys_AT;   // S1E0W
        when '100 0111 1000 100' return Sys_AT;   // S12E1R
        when '100 0111 1000 101' return Sys_AT;   // S12E1W
        when '100 0111 1000 110' return Sys_AT;   // S12E0R
        when '100 0111 1000 111' return Sys_AT;   // S12E0W
        when '011 0111 0100 001' return Sys_DC;   // ZVA
        when '000 0111 0110 001' return Sys_DC;   // IVAC
        when '000 0111 0110 010' return Sys_DC;   // ISW
        when '011 0111 1010 001' return Sys_DC;   // CVAC
        when '000 0111 1010 010' return Sys_DC;   // CSW
        when '011 0111 1011 001' return Sys_DC;   // CVAU
        when '011 0111 1110 001' return Sys_DC;   // CIVAC
        when '000 0111 1110 010' return Sys_DC;   // CISW
        when '011 0111 1101 001' return Sys_DC;   // CVADP
        when '000 0111 0001 000' return Sys_IC;   // IALLUIS
        when '000 0111 0101 000' return Sys_IC;   // IALLU
        when '011 0111 0101 001' return Sys_IC;   // IVAU
        when '100 1000 0000 001' return Sys_TLBI; // IPAS2E1IS
        when '100 1000 0000 101' return Sys_TLBI; // IPAS2LE1IS
        when '000 1000 0011 000' return Sys_TLBI; // VMALLE1IS
        when '100 1000 0011 000' return Sys_TLBI; // ALLE2IS
        when '110 1000 0011 000' return Sys_TLBI; // ALLE3IS
        when '000 1000 0011 001' return Sys_TLBI; // VAE1IS
        when '100 1000 0011 001' return Sys_TLBI; // VAE2IS
        when '110 1000 0011 001' return Sys_TLBI; // VAE3IS
        when '000 1000 0011 010' return Sys_TLBI; // ASIDE1IS
        when '000 1000 0011 011' return Sys_TLBI; // VAAE1IS
        when '100 1000 0011 100' return Sys_TLBI; // ALLE1IS
        when '000 1000 0011 101' return Sys_TLBI; // VALE1IS
        when '100 1000 0011 101' return Sys_TLBI; // VALE2IS
        when '110 1000 0011 101' return Sys_TLBI; // VALE3IS
        when '100 1000 0011 110' return Sys_TLBI; // VMALLS12E1IS
        when '000 1000 0011 111' return Sys_TLBI; // VAALE1IS
        when '100 1000 0100 001' return Sys_TLBI; // IPAS2E1
        when '100 1000 0100 101' return Sys_TLBI; // IPAS2LE1
        when '000 1000 0111 000' return Sys_TLBI; // VMALLE1
        when '100 1000 0111 000' return Sys_TLBI; // ALLE2
        when '110 1000 0111 000' return Sys_TLBI; // ALLE3
        when '000 1000 0111 001' return Sys_TLBI; // VAE1
        when '100 1000 0111 001' return Sys_TLBI; // VAE2
        when '110 1000 0111 001' return Sys_TLBI; // VAE3
        when '000 1000 0111 010' return Sys_TLBI; // ASIDE1
        when '000 1000 0111 011' return Sys_TLBI; // VAAE1
        when '100 1000 0111 100' return Sys_TLBI; // ALLE1
        when '000 1000 0111 101' return Sys_TLBI; // VALE1
        when '100 1000 0111 101' return Sys_TLBI; // VALE2
        when '110 1000 0111 101' return Sys_TLBI; // VALE3
        when '100 1000 0111 110' return Sys_TLBI; // VMALLS12E1
        when '000 1000 0111 111' return Sys_TLBI; // VAALE1
    return Sys_SYS;
```

Library pseudocode for aarch64/instrs/system/sysops/sysop/SystemOp

```
enumeration SystemOp {Sys_AT, Sys_DC, Sys_IC, Sys_TLBI, Sys_SYS};
```

Library pseudocode for aarch64/instrs/vector/arithmetic/binary/uniform/logical/bsl-eor/vbitop/VBitOp

```
enumeration VBitOp      {VBitOp_VBIF, VBitOp_VBIT, VBitOp_VBSL, VBitOp_VEOR};
```

Library pseudocode for aarch64/instrs/vector/arithmetic/unary/cmp/compareop/CompareOp

```
enumeration CompareOp   {CompareOp_GT, CompareOp_GE, CompareOp_EQ,
                         CompareOp_LE, CompareOp_LT};
```

Library pseudocode for aarch64/instrs/vector/logical/immediateop/ImmediateOp

```
enumeration ImmediateOp {ImmediateOp_MOVI, ImmediateOp_MVNI,
                         ImmediateOp_ORR, ImmediateOp_BIC};
```

Library pseudocode for aarch64/instrs/vector/reduce/reduceop/Reduce

```
// Reduce()
// ========

bits(esize) Reduce(ReduceOp op, bits(N) input, integer esize)
    integer half;
    bits(esize) hi;
    bits(esize) lo;
    bits(esize) result;

    if N == esize then
        return input<esize-1:0>;

    half = N DIV 2;
    hi = Reduce(op, input<N-1:half>, esize);
    lo = Reduce(op, input<half-1:0>, esize);

    case op of
        when ReduceOp_FMINNUM
            result = FPMinNum(lo, hi, FPCR);
        when ReduceOp_FMAXNUM
            result = FPMaxNum(lo, hi, FPCR);
        when ReduceOp_FMIN
            result = FPMin(lo, hi, FPCR);
        when ReduceOp_FMAX
            result = FPMax(lo, hi, FPCR);
        when ReduceOp_FADD
            result = FPAdd(lo, hi, FPCR);
        when ReduceOp_ADD
            result = lo + hi;

    return result;
```

Library pseudocode for aarch64/instrs/vector/reduce/reduceop/ReduceOp

```
enumeration ReduceOp {ReduceOp_FMINNUM, ReduceOp_FMAXNUM,
                      ReduceOp_FMIN, ReduceOp_FMAX,
                      ReduceOp_FADD, ReduceOp_ADD};
```

Library pseudocode for aarch64/translation/attrs/AArch64.InstructionDevice

```
// AArch64.InstructionDevice()
// ===========================
// Instruction fetches from memory marked as Device but not execute-never might generate a
// Permission Fault but are otherwise treated as if from Normal Non-cacheable memory.

AddressDescriptor AArch64.InstructionDevice(AddressDescriptor addrdesc, bits(64) vaddress,
                                            bits(52) ipaddress, integer level,
                                            AccType acctype, boolean iswrite, boolean secondstage,
                                            boolean s2fs1walk)

    c = ConstrainUnpredictable(Unpredictable_INSTRDEVICE);
    assert c IN {Constraint_NONE, Constraint_FAULT};

    if c == Constraint_FAULT then
        addrdesc.fault = AArch64.PermissionFault(ipaddress, boolean UNKNOWN,  level, acctype, iswrite,
                                                 secondstage, s2fs1walk);
    else
        addrdesc.mattrs.memtype = MemType_Normal;
        addrdesc.mattrs.inner.attrs = MemAttr_NC;
        addrdesc.mattrs.inner.hints = MemHint_No;
        addrdesc.mattrs.outer = addrdesc.mattrs.inner;
        addrdesc.mattrs.tagged = FALSE;
        addrdesc.mattrs = MemAttrDefaults(addrdesc.mattrs);

    return addrdesc;
```

Library pseudocode for aarch64/translation/attrs/AArch64.S1AttrDecode

```
// AArch64.S1AttrDecode()
// ======================
// Converts the Stage 1 attribute fields, using the MAIR, to orthogonal
// attributes and hints.

MemoryAttributes AArch64.S1AttrDecode(bits(2) SH, bits(3) attr, AccType acctype)

    MemoryAttributes mematTrs;

    mair = MAIR[];
    index = 8 * UInt(attr);
    attrfield = mair<index+7:index>;

    mematTrs.tagged = FALSE;
    if ((attrfield<7:4> != '0000' && attrfield<7:4> != '1111' && attrfield<3:0> == '0000') ||
        (attrfield<7:4> == '0000' && attrfield<3:0> != 'xx00')) then
        // Reserved, maps to an allocated value
        (-, attrfield) = ConstrainUnpredictableBits(Unpredictable_RESMAIR);
    if !HaveMTEExt() && attrfield<7:4> == '1111' && attrfield<3:0> == '0000' then
        // Reserved, maps to an allocated value
        (-, attrfield) = ConstrainUnpredictableBits(Unpredictable_RESMAIR);

    if attrfield<7:4> == '0000' then            // Device
        mematTrs.memtype = MemType_Device;
        case attrfield<3:0> of
            when '0000'  mematTrs.device = DeviceType_nGnRnE;
            when '0100'  mematTrs.device = DeviceType_nGnRE;
            when '1000'  mematTrs.device = DeviceType_nGRE;
            when '1100'  mematTrs.device = DeviceType_GRE;
            otherwise    Unreachable();         // Reserved, handled above

    elsif attrfield<3:0> != '0000'  then        // Normal
        mematTrs.memtype = MemType_Normal;
        mematTrs.outer = LongConvertAttrsHints(attrfield<7:4>, acctype);
        mematTrs.inner = LongConvertAttrsHints(attrfield<3:0>, acctype);
        mematTrs.shareable = SH<1> == '1';
        mematTrs.outershareable = SH == '10';
    elsif HaveMTEExt() && attrfield == '11110000' then // Normal, Tagged if WB-RWA
        mematTrs.memtype = MemType_Normal;
        mematTrs.outer = LongConvertAttrsHints('1111', acctype); // WB_RWA
        mematTrs.inner = LongConvertAttrsHints('1111', acctype); // WB_RWA
        mematTrs.shareable = SH<1> == '1';
        mematTrs.outershareable = SH == '10';
        mematTrs.tagged = (mematTrs.inner.attrs == MemAttr_WB &&
                           mematTrs.inner.hints == MemHint_RWA &&
                           mematTrs.outer.attrs == MemAttr_WB &&
                           mematTrs.outer.hints == MemHint_RWA);
    else
        Unreachable();                          // Reserved, handled above

    return MemAttrDefaults(mematTrs);
```

Library pseudocode for aarch64/translation/attrs/AArch64.TranslateAddressS1Off

```
// AArch64.TranslateAddressS1Off()
// ===============================
// Called for stage 1 translations when translation is disabled to supply a default translation.
// Note that there are additional constraints on instruction prefetching that are not described in
// this pseudocode.

TLBRecord AArch64.TranslateAddressS1Off(bits(64) vaddress, AccType acctype, boolean iswrite)
    assert !ELUsingAArch32(S1TranslationRegime());

    TLBRecord result;

    Top = AddrTop(vaddress, (acctype == AccType_IFETCH), PSTATE.EL);
    if !IsZero(vaddress<Top:PAMax()>) then
        level = 0;
        ipaddress = bits(52) UNKNOWN;
        secondstage = FALSE;
        s2fs1walk = FALSE;
        result.addrdesc.fault = AArch64.AddressSizeFault(ipaddress,boolean UNKNOWN,  level, acctype,
                                                         iswrite, secondstage, s2fs1walk);
        return result;

    default_cacheable = (HasS2Translation() && HCR_EL2.DC == '1');

    if default_cacheable then
        // Use default cacheable settings
        result.addrdesc.memattrs.memtype = MemType_Normal;
        result.addrdesc.memattrs.inner.attrs = MemAttr_WB;      // Write-back
        result.addrdesc.memattrs.inner.hints = MemHint_RWA;
        result.addrdesc.memattrs.shareable = FALSE;
        result.addrdesc.memattrs.outershareable = FALSE;
        result.addrdesc.memattrs.tagged = HCR_EL2.DCT == '1';
    elsif acctype != AccType_IFETCH then
        // Treat data as Device
        result.addrdesc.memattrs.memtype = MemType_Device;
        result.addrdesc.memattrs.device = DeviceType_nGnRnE;
        result.addrdesc.memattrs.inner = MemAttrHints UNKNOWN;
        result.addrdesc.memattrs.tagged = FALSE;
    else
        // Instruction cacheability controlled by SCTLR_ELx.I
        cacheable = SCTLR[].I == '1';
        result.addrdesc.memattrs.memtype = MemType_Normal;
        if cacheable then
            result.addrdesc.memattrs.inner.attrs = MemAttr_WT;
            result.addrdesc.memattrs.inner.hints = MemHint_RA;
        else
            result.addrdesc.memattrs.inner.attrs = MemAttr_NC;
            result.addrdesc.memattrs.inner.hints = MemHint_No;
        result.addrdesc.memattrs.shareable = TRUE;
        result.addrdesc.memattrs.outershareable = TRUE;
        result.addrdesc.memattrs.tagged = FALSE;

    result.addrdesc.memattrs.outer = result.addrdesc.memattrs.inner;

    result.addrdesc.memattrs = MemAttrDefaults(result.addrdesc.memattrs);

    result.perms.ap = bits(3) UNKNOWN;
    result.perms.xn = '0';
    result.perms.pxn = '0';

    result.nG = bit UNKNOWN;
    result.contiguous = boolean UNKNOWN;
    result.domain = bits(4) UNKNOWN;
    result.level = integer UNKNOWN;
    result.blocksize = integer UNKNOWN;
    result.addrdesc.paddress.address = vaddress<51:0>;
    result.addrdesc.paddress.NS = if IsSecure() then '0' else '1';
    result.addrdesc.fault = AArch64.NoFault();
    return result;
```

Library pseudocode for aarch64/translation/checks/AArch64.AccessIsPrivileged

```
// AArch64.AccessIsPrivileged()
// ============================

boolean AArch64.AccessIsPrivileged(AccType acctype)

    el = AArch64.AccessUsesEL(acctype);

    if el == EL0 then
        ispriv = FALSE;
    elsif el == EL3 then
        ispriv = TRUE;
    elsif el == EL2 && (!IsInHost() || HCR_EL2.TGE == '0') then
        ispriv = TRUE;
    elsif HaveUAOExt() && PSTATE.UAO == '1' then
        ispriv = TRUE;
    else
        ispriv = (acctype != AccType_UNPRIV);

    return ispriv;
```

Library pseudocode for aarch64/translation/checks/AArch64.AccessUsesEL

```
// AArch64.AccessUsesEL()
// ======================
// Returns the Exception Level of the regime that will manage the translation for a given access type.

bits(2) AArch64.AccessUsesEL(AccType acctype)
    if acctype == AccType_UNPRIV then
        return EL0;
    elsif acctype == AccType_NV2REGISTER then
        return EL2;
    else
        return PSTATE.EL;
```

Library pseudocode for aarch64/translation/checks/AArch64.CheckPermission

```
// AArch64.CheckPermission()
// =========================
// Function used for permission checking from AArch64 stage 1 translations

FaultRecord AArch64.CheckPermission(Permissions perms, bits(64) vaddress, integer level,
                                    bit NS, AccType acctype, boolean iswrite)
    assert !ELUsingAArch32(S1TranslationRegime());

    wxn = SCTLR[].WXN == '1';

    if (PSTATE.EL == EL0 ||
        IsInHost() ||
        (PSTATE.EL == EL1 && !HaveNV2Ext()) ||
        (PSTATE.EL == EL1 && HaveNV2Ext() && (acctype != AccType_NV2REGISTER || !ELIsInHost(EL2)))) then
        priv_r = TRUE;
        priv_w = perms.ap<2> == '0';
        user_r = perms.ap<1> == '1';
        user_w = perms.ap<2:1> == '01';

        ispriv = AArch64.AccessIsPrivileged(acctype);

        pan = if HavePANExt() then PSTATE.PAN else '0';
        if (EL2Enabled() && ((PSTATE.EL == EL1 && HaveNVExt() && HCR_EL2.<NV, NV1> == '11') ||
            (HaveNV2Ext() && acctype == AccType_NV2REGISTER && HCR_EL2.NV2 == '1'))) then
            pan = '0';
        is_ldst   = !(acctype IN {AccType_DC, AccType_DC_UNPRIV, AccType_AT, AccType_IFETCH});
        is_ats1xp = (acctype == AccType_AT && AArch64.ExecutingATS1xPInstr());
        if pan == '1' && user_r && ispriv && (is_ldst || is_ats1xp) then
            priv_r = FALSE;
            priv_w = FALSE;

        user_xn = perms.xn == '1' || (user_w && wxn);
        priv_xn = perms.pxn == '1' || (priv_w && wxn) || user_w;

        if ispriv then
            (r, w, xn) = (priv_r, priv_w, priv_xn);
        else
            (r, w, xn) = (user_r, user_w, user_xn);
    else
        // Access from EL2 or EL3
        r = TRUE;
        w = perms.ap<2> == '0';
        xn = perms.xn == '1' || (w && wxn);

    // Restriction on Secure instruction fetch
    if HaveEL(EL3) && IsSecure() && NS == '1' && SCR_EL3.SIF == '1' then
        xn = TRUE;

    if acctype == AccType_IFETCH then
        fail = xn;
        failedread = TRUE;
    elsif acctype IN { AccType_ATOMICRW, AccType_ORDEREDRW, AccType_ORDEREDATOMICRW } then
        fail = !r || !w;
        failedread = !r;
    elsif iswrite then
        fail = !w;
        failedread = FALSE;
    elsif acctype == AccType_DC && PSTATE.EL != EL0 then
        // DC maintenance instructions operating by VA, cannot fault from stage 1 translation,
        // other than DC IVAC, which requires write permission, and operations executed at EL0,
        // which require read permission.
        fail = FALSE;
    else
        fail = !r;
        failedread = TRUE;

    if fail then
        secondstage = FALSE;
        s2fs1walk = FALSE;
        ipaddress = bits(52) UNKNOWN;
```

```
        return AArch64.PermissionFault(ipaddress,boolean UNKNOWN,  level, acctype,
                                       !failedread, secondstage, s2fs1walk);
    else
        return AArch64.NoFault();
```

Library pseudocode for aarch64/translation/checks/AArch64.CheckS2Permission

```
// AArch64.CheckS2Permission()
// ===========================
// Function used for permission checking from AArch64 stage 2 translations

FaultRecord AArch64.CheckS2Permission(Permissions perms, bits(64) vaddress, bits(52) ipaddress,
                                      integer level, AccType acctype, boolean iswrite, boolean NS,
                                      boolean s2fs1walk, boolean hwupdatewalk)

    assert IsSecureEL2Enabled() || ( HaveEL(EL2) && !IsSecure() && !ELUsingAArch32(EL2) ) && HasS2Transla

    r = perms.ap<1> == '1';
    w = perms.ap<2> == '1';
    if HaveExtendedExecuteNeverExt() then
        case perms.xn:perms.xxn of
            when '00'  xn = FALSE;
            when '01'  xn = PSTATE.EL == EL1;
            when '10'  xn = TRUE;
            when '11'  xn = PSTATE.EL == EL0;
    else
        xn = perms.xn == '1';
    // Stage 1 walk is checked as a read, regardless of the original type
    if acctype == AccType_IFETCH && !s2fs1walk then
        fail = xn;
        failedread = TRUE;
    elsif (acctype IN { AccType_ATOMICRW, AccType_ORDEREDRW, AccType_ORDEREDATOMICRW }) && !s2fs1walk the
        fail = !r || !w;
        failedread = !r;
    elsif iswrite && !s2fs1walk then
        fail = !w;
        failedread = FALSE;
    elsif acctype == AccType_DC && PSTATE.EL != EL0 && !s2fs1walk then
        // DC maintenance instructions operating by VA, with the exception of DC IVAC, do
        // not generate Permission faults from stage 2 translation, other than when
        // performing a stage 1 translation table walk.
        fail = FALSE;
    elsif hwupdatewalk then
        fail = !w;
        failedread = !iswrite;
    else
        fail = !r;
        failedread = !iswrite;

    if fail then
        domain = bits(4) UNKNOWN;
        secondstage = TRUE;
        return AArch64.PermissionFault(ipaddress,NS,  level, acctype,
                                       !failedread, secondstage, s2fs1walk);
    else
        return AArch64.NoFault();
```

Library pseudocode for aarch64/translation/debug/AArch64.CheckBreakpoint

```
// AArch64.CheckBreakpoint()
// =========================
// Called before executing the instruction of length "size" bytes at "vaddress" in an AArch64
// translation regime.
// The breakpoint can in fact be evaluated well ahead of execution, for example, at instruction
// fetch. This is the simple sequential execution of the program.

FaultRecord AArch64.CheckBreakpoint(bits(64) vaddress, AccType acctype, integer size)
    assert !ELUsingAArch32(S1TranslationRegime());
    assert (UsingAArch32() && size IN {2,4}) || size == 4;

    match = FALSE;

    for i = 0 to UInt(ID_AA64DFR0_EL1.BRPs)
        match_i = AArch64.BreakpointMatch(i, vaddress, acctype, size);
        match = match || match_i;

    if match && HaltOnBreakpointOrWatchpoint() then
        reason = DebugHalt_Breakpoint;
        Halt(reason);
    elsif match && MDSCR_EL1.MDE == '1' && AArch64.GenerateDebugExceptions() then
        acctype = AccType_IFETCH;
        iswrite = FALSE;
        return AArch64.DebugFault(acctype, iswrite);
    else
        return AArch64.NoFault();
```

Library pseudocode for aarch64/translation/debug/AArch64.CheckDebug

```
// AArch64.CheckDebug()
// ====================
// Called on each access to check for a debug exception or entry to Debug state.

FaultRecord AArch64.CheckDebug(bits(64) vaddress, AccType acctype, boolean iswrite, integer size)

    FaultRecord fault = AArch64.NoFault();

    d_side = (acctype != AccType_IFETCH);
    if generate_exception = HaveNV2Ext() && acctype == AccType_NV2REGISTER then
        mask = '0';
        generate_exception = AArch64.GenerateDebugExceptionsFrom(EL2, IsSecure(), mask) && MDSCR_EL1.MDE
    else
        generate_exception = AArch64.GenerateDebugExceptions() && MDSCR_EL1.MDE == '1';
    halt = HaltOnBreakpointOrWatchpoint();

    if generate_exception || halt then
        if d_side then
            fault = AArch64.CheckWatchpoint(vaddress, acctype, iswrite, size);
        else
            fault = AArch64.CheckBreakpoint(vaddress, acctype, size);

    return fault;
```

Library pseudocode for aarch64/translation/debug/AArch64.CheckWatchpoint

```
// AArch64.CheckWatchpoint()
// =========================
// Called before accessing the memory location of "size" bytes at "address".

FaultRecord AArch64.CheckWatchpoint(bits(64) vaddress, AccType acctype,
                                    boolean iswrite, integer size)
    assert !ELUsingAArch32(S1TranslationRegime());

    match = FALSE;
    ispriv = AArch64.AccessIsPrivileged(acctype);

    for i = 0 to UInt(ID_AA64DFR0_EL1.WRPs)
        match = match || AArch64.WatchpointMatch(i, vaddress, size, ispriv, acctype, iswrite);

    if match && HaltOnBreakpointOrWatchpoint() then
        if acctype != AccType_NONFAULT && acctype != AccType_CNOTFIRST then
            reason = DebugHalt_Watchpoint;
            Halt(reason);
        else
            // Fault will be reported and cancelled
            return AArch64.DebugFault(acctype, iswrite);
    elsif match && MDSCR_EL1.MDE == '1' && AArch64.GenerateDebugExceptions() then
        return AArch64.DebugFault(acctype, iswrite);
    else
        return AArch64.NoFault();
```

Library pseudocode for aarch64/translation/faults/AArch64.AccessFlagFault

```
// AArch64.AccessFlagFault()
// =========================

FaultRecord AArch64.AccessFlagFault(bits(52) ipaddress,boolean NS, integer level,
                                    AccType acctype, boolean iswrite, boolean secondstage,
                                    boolean s2fs1walk)

    extflag = bit UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch64.CreateFaultRecord(Fault_AccessFlag, ipaddress, NS, level, acctype, iswrite,
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.AddressSizeFault

```
// AArch64.AddressSizeFault()
// ==========================

FaultRecord AArch64.AddressSizeFault(bits(52) ipaddress,boolean NS, integer level,
                                     AccType acctype, boolean iswrite, boolean secondstage,
                                     boolean s2fs1walk)

    extflag = bit UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch64.CreateFaultRecord(Fault_AddressSize, ipaddress, NS, level, acctype, iswrite,
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.AlignmentFault

```
// AArch64.AlignmentFault()
// ========================

FaultRecord AArch64.AlignmentFault(AccType acctype, boolean iswrite, boolean secondstage)

    ipaddress = bits(52) UNKNOWN;
    level = integer UNKNOWN;
    extflag = bit UNKNOWN;
    errortype = bits(2) UNKNOWN;
    s2fs1walk = boolean UNKNOWN;

    return AArch64.CreateFaultRecord(Fault_Alignment, ipaddress, boolean UNKNOWN, level, acctype, iswrite
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.AsynchExternalAbort

```
// AArch64.AsynchExternalAbort()
// =============================
// Wrapper function for asynchronous external aborts

FaultRecord AArch64.AsynchExternalAbort(boolean parity, bits(2) errortype, bit extflag)

    faulttype = if parity then Fault_AsyncParity else Fault_AsyncExternal;
    ipaddress = bits(52) UNKNOWN;
    level = integer UNKNOWN;
    acctype = AccType_NORMAL;
    iswrite = boolean UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch64.CreateFaultRecord(faulttype, ipaddress, boolean UNKNOWN, level, acctype, iswrite, extf
                                     errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.DebugFault

```
// AArch64.DebugFault()
// ====================

FaultRecord AArch64.DebugFault(AccType acctype, boolean iswrite)

    ipaddress = bits(52) UNKNOWN;
    errortype = bits(2) UNKNOWN;
    level = integer UNKNOWN;
    extflag = bit UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch64.CreateFaultRecord(Fault_Debug, ipaddress, boolean UNKNOWN, level, acctype, iswrite,
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.NoFault

```
// AArch64.NoFault()
// =================

FaultRecord AArch64.NoFault()

    ipaddress = bits(52) UNKNOWN;
    level = integer UNKNOWN;
    acctype = AccType_NORMAL;
    iswrite = boolean UNKNOWN;
    extflag = bit UNKNOWN;
    errortype = bits(2) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    return AArch64.CreateFaultRecord(Fault_None, ipaddress, boolean UNKNOWN, level, acctype, iswrite,
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.PermissionFault

```
// AArch64.PermissionFault()
// =========================

FaultRecord AArch64.PermissionFault(bits(52) ipaddress,boolean NS, integer level,
                                    AccType acctype, boolean iswrite, boolean secondstage,
                                    boolean s2fs1walk)

    extflag = bit UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch64.CreateFaultRecord(Fault_Permission, ipaddress, NS, level, acctype, iswrite,
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/faults/AArch64.TranslationFault

```
// AArch64.TranslationFault()
// ==========================

FaultRecord AArch64.TranslationFault(bits(52) ipaddress, boolean NS, integer level,
                                     AccType acctype, boolean iswrite, boolean secondstage,
                                     boolean s2fs1walk)

    extflag = bit UNKNOWN;
    errortype = bits(2) UNKNOWN;
    return AArch64.CreateFaultRecord(Fault_Translation, ipaddress, NS, level, acctype, iswrite,
                                     extflag, errortype, secondstage, s2fs1walk);
```

Library pseudocode for aarch64/translation/translation/AArch64.CheckAndUpdateDescriptor

```
// AArch64.CheckAndUpdateDescriptor()
// ==================================
// Check and update translation table descriptor if hardware update is configured

FaultRecord AArch64.CheckAndUpdateDescriptor(DescriptorUpdate result, FaultRecord fault,
                                             boolean secondstage, bits(64) vaddress, AccType acctype,
                                             boolean iswrite, boolean s2fs1walk, boolean hwupdatewalk)

    boolean hw_update_AF = FALSE;
    boolean hw_update_AP = FALSE;

    // Check if access flag can be updated
    // Address translation instructions are permitted to update AF but not required
    if result.AF then
        if fault.statuscode == Fault_None || ConstrainUnpredictable(Unpredictable_AFUPDATE) == Constraint
            hw_update_AF = TRUE;

    if result.AP && fault.statuscode == Fault_None then
        write_perm_req = (iswrite || acctype IN {AccType_ATOMICRW,AccType_ORDEREDRW, AccType_ORDEREDATOMI
        hw_update_AP = (write_perm_req && !(acctype IN {AccType_AT, AccType_DC, AccType_DC_UNPRIV})) || h

    if hw_update_AF || hw_update_AP then
        if secondstage || !HasS2Translation() then
            descaddr2 = result.descaddr;
        else
            hwupdatewalk = TRUE;
            descaddr2 = AArch64.SecondStageWalk(result.descaddr, vaddress, acctype, iswrite, 8, hwupdatew
            if IsFault(descaddr2) then
                return descaddr2.fault;

        accdesc = CreateAccessDescriptor(AccType_ATOMICRW, FALSE);
        desc = _Mem[descaddr2, 8, accdesc];
        el = AArch64.AccessUsesEL(acctype);
        case el of
            when EL3
                reversedescriptors = SCTLR_EL3.EE == '1';
            when EL2
                reversedescriptors = SCTLR_EL2.EE == '1';
            otherwise
                reversedescriptors = SCTLR_EL1.EE == '1';
        if reversedescriptors then
            desc = BigEndianReverse(desc);

        if hw_update_AF then
            desc<10> = '1';
        if hw_update_AP then
            desc<7> = (if secondstage then '1' else '0');

        _Mem[descaddr2,8,accdesc] = if reversedescriptors then BigEndianReverse(desc) else desc;

    return fault;
```

Library pseudocode for aarch64/translation/translation/AArch64.FirstStageTranslate

```
// AArch64.FirstStageTranslate()
// =============================
// Perform a stage 1 translation walk. The function used by Address Translation operations is
// similar except it uses the translation regime specified for the instruction.

AddressDescriptor AArch64.FirstStageTranslate(bits(64) vaddress, AccType acctype, boolean iswrite,
                                              boolean wasaligned, integer size)

    if HaveNV2Ext() && acctype == AccType_NV2REGISTER then
        s1_enabled = SCTLR_EL2.M == '1';
    elsif HasS2Translation() then
        s1_enabled = HCR_EL2.TGE == '0' && HCR_EL2.DC == '0' && SCTLR_EL1.M == '1';
    else
        s1_enabled = SCTLR[].M == '1';

    ipaddress = bits(52) UNKNOWN;
    secondstage = FALSE;
    s2fs1walk = FALSE;

    if s1_enabled then                          // First stage enabled
        S1 = AArch64.TranslationTableWalk(ipaddress, TRUE, vaddress, acctype, iswrite, secondstage,
                                          s2fs1walk, size);
        permissioncheck = TRUE;
        if acctype == AccType_IFETCH then
            InGuardedPage = S1.GP == '1';       // Global state updated on instruction fetch that denotes
                                                // if the fetched instruction is from a guarded page.
    else
        S1 = AArch64.TranslateAddressS1Off(vaddress, acctype, iswrite);
        permissioncheck = FALSE;

    if UsingAArch32() && HaveTrapLoadStoreMultipleDeviceExt() && AArch32.ExecutingLSMInstr() then
        if S1.addrdesc.memattrs.memtype == MemType_Device && S1.addrdesc.memattrs.device != DeviceType_GR
            nTLSMD = if S1TranslationRegime() == EL2 then SCTLR_EL2.nTLSMD else SCTLR_EL1.nTLSMD;
            if nTLSMD == '0' then
                S1.addrdesc.fault = AArch64.AlignmentFault(acctype, iswrite, secondstage);

    // Check for unaligned data accesses to Device memory
    if ((!wasaligned && acctype != AccType_IFETCH) || (acctype == AccType_DCZVA))
        && S1.addrdesc.memattrs.memtype == MemType_Device && !IsFault(S1.addrdesc) then
        S1.addrdesc.fault = AArch64.AlignmentFault(acctype, iswrite, secondstage);
    if !IsFault(S1.addrdesc) && permissioncheck then
        S1.addrdesc.fault = AArch64.CheckPermission(S1.perms, vaddress, S1.level,
                                                    S1.addrdesc.paddress.NS,
                                                    acctype, iswrite);

    // Check for instruction fetches from Device memory not marked as execute-never. If there has
    // not been a Permission Fault then the memory is not marked execute-never.
    if (!IsFault(S1.addrdesc) && S1.addrdesc.memattrs.memtype == MemType_Device &&
        acctype == AccType_IFETCH) then
        S1.addrdesc = AArch64.InstructionDevice(S1.addrdesc, vaddress, ipaddress, S1.level,
                                                acctype, iswrite,
                                                secondstage, s2fs1walk);
    // Check and update translation table descriptor if required
    hwupdatewalk = FALSE;
    s2fs1walk = FALSE;
    S1.addrdesc.fault = AArch64.CheckAndUpdateDescriptor(S1.descupdate, S1.addrdesc.fault,
                                                         secondstage, vaddress, acctype,
                                                         iswrite, s2fs1walk, hwupdatewalk);

    return S1.addrdesc;
```

Library pseudocode for aarch64/translation/translation/AArch64.FullTranslate

```
// AArch64.FullTranslate()
// =======================
// Perform both stage 1 and stage 2 translation walks for the current translation regime. The
// function used by Address Translation operations is similar except it uses the translation
// regime specified for the instruction.

AddressDescriptor AArch64.FullTranslate(bits(64) vaddress, AccType acctype, boolean iswrite,
                                        boolean wasaligned, integer size)

    // First Stage Translation
    S1 = AArch64.FirstStageTranslate(vaddress, acctype, iswrite, wasaligned, size);
    if !IsFault(S1) && !(HaveNV2Ext() && acctype == AccType_NV2REGISTER) && HasS2Translation() then
        s2fs1walk = FALSE;
        hwupdatewalk = FALSE;
        result = AArch64.SecondStageTranslate(S1, vaddress, acctype, iswrite, wasaligned, s2fs1walk,
                                              size, hwupdatewalk);
    else
        result = S1;

    return result;
```

Library pseudocode for aarch64/translation/translation/AArch64.SecondStageTranslate

```
// AArch64.SecondStageTranslate()
// ==============================
// Perform a stage 2 translation walk. The function used by Address Translation operations is
// similar except it uses the translation regime specified for the instruction.

AddressDescriptor AArch64.SecondStageTranslate(AddressDescriptor S1, bits(64) vaddress,
                                               AccType acctype, boolean iswrite, boolean wasaligned,
                                               boolean s2fs1walk, integer size, boolean hwupdatewalk)
    assert HasS2Translation();

    s2_enabled = HCR_EL2.VM == '1' || HCR_EL2.DC == '1';
    secondstage = TRUE;

    if s2_enabled then                          // Second stage enabled
        ipaddress = S1.paddress.address<51:0>;
        NS = S1.paddress.NS == '1';
        S2 = AArch64.TranslationTableWalk(ipaddress, NS, vaddress, acctype, iswrite, secondstage,
                                          s2fs1walk, size);

        // Check for unaligned data accesses to Device memory
        if ((!wasaligned && acctype != AccType_IFETCH) || (acctype == AccType_DCZVA))
            && S2.addrdesc.memattrs.memtype == MemType_Device && !IsFault(S2.addrdesc) then
            S2.addrdesc.fault = AArch64.AlignmentFault(acctype, iswrite, secondstage);

        // Check for permissions on Stage2 translations
        if !IsFault(S2.addrdesc) then
            S2.addrdesc.fault = AArch64.CheckS2Permission(S2.perms, vaddress, ipaddress, S2.level,
                                                          acctype, iswrite, NS,s2fs1walk, hwupdatewalk);

        // Check for instruction fetches from Device memory not marked as execute-never. As there
        // has not been a Permission Fault then the memory is not marked execute-never.
        if (!s2fs1walk && !IsFault(S2.addrdesc) && S2.addrdesc.memattrs.memtype == MemType_Device &&
            acctype == AccType_IFETCH) then
            S2.addrdesc = AArch64.InstructionDevice(S2.addrdesc, vaddress, ipaddress, S2.level,
                                                    acctype, iswrite,
                                                    secondstage, s2fs1walk);

        // Check for protected table walk
        if (s2fs1walk && !IsFault(S2.addrdesc) && HCR_EL2.PTW == '1' &&
            S2.addrdesc.memattrs.memtype == MemType_Device) then
            S2.addrdesc.fault = AArch64.PermissionFault(ipaddress, NS,  S2.level, acctype,
                                                        iswrite, secondstage, s2fs1walk);

        // Check and update translation table descriptor if required
        S2.addrdesc.fault = AArch64.CheckAndUpdateDescriptor(S2.descupdate, S2.addrdesc.fault,
                                                             secondstage, vaddress, acctype,
                                                             iswrite, s2fs1walk, hwupdatewalk);
        result = CombineS1S2Desc(S1, S2.addrdesc);
    else
        result = S1;

    return result;
```

Library pseudocode for aarch64/translation/translation/AArch64.SecondStageWalk

```
// AArch64.SecondStageWalk()
// =========================
// Perform a stage 2 translation on a stage 1 translation page table walk access.

AddressDescriptor AArch64.SecondStageWalk(AddressDescriptor S1, bits(64) vaddress, AccType acctype,
                                          boolean iswrite, integer size, boolean hwupdatewalk)

    assert HasS2Translation();

    s2fs1walk = TRUE;
    wasaligned = TRUE;
    return AArch64.SecondStageTranslate(S1, vaddress, acctype, iswrite, wasaligned, s2fs1walk,
                                        size, hwupdatewalk);
```

Library pseudocode for aarch64/translation/translation/AArch64.TranslateAddress

```
// AArch64.TranslateAddress()
// ==========================
// Main entry point for translating an address

AddressDescriptor AArch64.TranslateAddress(bits(64) vaddress, AccType acctype, boolean iswrite,
                                           boolean wasaligned, integer size)

    result = AArch64.FullTranslate(vaddress, acctype, iswrite, wasaligned, size);

    if !(acctype IN {AccType_PTW, AccType_IC, AccType_AT}) && !IsFault(result) then
        result.fault = AArch64.CheckDebug(vaddress, acctype, iswrite, size);

    // Update virtual address for abort functions
    result.vaddress = ZeroExtend(vaddress);

    return result;
```

Library pseudocode for aarch64/translation/walk/AArch64.TranslationTableWalk

```
// AArch64.TranslationTableWalk()
// ==============================
// Returns a result of a translation table walk
//
// Implementations might cache information from memory in any number of non-coherent TLB
// caching structures, and so avoid memory accesses that have been expressed in this
// pseudocode. The use of such TLBs is not expressed in this pseudocode.

TLBRecord AArch64.TranslationTableWalk(bits(52) ipaddress, boolean s1_nonsecure, bits(64) vaddress,
                                       AccType acctype, boolean iswrite, boolean secondstage,
                                       boolean s2fs1walk, integer size)
    if !secondstage then
        assert !ELUsingAArch32(S1TranslationRegime());
    else
        assert IsSecureEL2Enabled() || ( HaveEL(EL2) && !IsSecure() && !ELUsingAArch32(EL2) ) && HasS2Tra

    TLBRecord result;
    AddressDescriptor descaddr;
    bits(64) baseregister;
    bits(64) inputaddr;         // Input Address is 'vaddress' for stage 1, 'ipaddress' for stage 2
    bit nswalk;                     // Stage 2 translation table walks are to Secure or to Non-secure PA s

    descaddr.memattrs.memtype = MemType_Normal;

    // Derived parameters for the page table walk:
    //  grainsize = Log2(Size of Table)         - Size of Table is 4KB, 16KB or 64KB in AArch64
    //  stride = Log2(Address per Level)        - Bits of address consumed at each level
    //  firstblocklevel = First level where a block entry is allowed
    //  ps = Physical Address size as encoded in TCR_EL1.IPS or TCR_ELx/VTCR_EL2.PS
    //  inputsize = Log2(Size of Input Address) - Input Address size in bits
    //  level = Level to start walk from
    // This means that the number of levels after start level = 3-level

    if !secondstage then
        // First stage translation
        inputaddr = ZeroExtend(vaddress);
        el = AArch64.AccessUsesEL(acctype);
        top = AddrTop(inputaddr, (acctype == AccType_IFETCH), el);
        if el == EL3 then
            largegrain = TCR_EL3.TG0 == '01';
            midgrain = TCR_EL3.TG0 == '10';
            inputsize = 64 - UInt(TCR_EL3.T0SZ);
            inputsize_max = if Have52BitVAExt() && largegrain then 52 else 48;
            inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 48);
            if inputsize < inputsize_min then
                c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
                assert c IN {Constraint_FORCE, Constraint_FAULT};
                if c == Constraint_FORCE then inputsize = inputsize_min;
            ps = TCR_EL3.PS;
            basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsZero(inputaddr<top:
            disabled = FALSE;
            baseregister = TTBR0_EL3;
            descaddr.memattrs = WalkAttrDecode(TCR_EL3.SH0, TCR_EL3.ORGN0, TCR_EL3.IRGN0, secondstage);
            reversedescriptors = SCTLR_EL3.EE == '1';
            lookupsecure = TRUE;
            singlepriv = TRUE;
            update_AF = HaveAccessFlagUpdateExt() && TCR_EL3.HA == '1';
            update_AP = HaveDirtyBitModifierExt() && update_AF && TCR_EL3.HD == '1';
            hierattrsdisabled = AArch64.HaveHPDExt() && TCR_EL3.HPD == '1';
        elsif ELIsInHost(el) then
            if inputaddr<top> == '0' then
                largegrain = TCR_EL2.TG0 == '01';
                midgrain = TCR_EL2.TG0 == '10';
                inputsize = 64 - UInt(TCR_EL2.T0SZ);
                inputsize_max = if Have52BitVAExt() && largegrain then 52 else 48;
                inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 4
                if inputsize < inputsize_min then
                    c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
                    assert c IN {Constraint_FORCE, Constraint_FAULT};
                    if c == Constraint_FORCE then inputsize = inputsize_min;
```

```
            basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsZero(inputaddr<
            disabled = TCR_EL2.EPD0 == '1' || (PSTATE.EL == EL0 && HaveE0PDExt() && TCR_EL2.E0PD0 ==
            baseregister = TTBR0_EL2;
            descaddr.memattrs = WalkAttrDecode(TCR_EL2.SH0, TCR_EL2.ORGN0, TCR_EL2.IRGN0, secondstage
            hierattrsdisabled = AArch64.HaveHPDExt() && TCR_EL2.HPD0 == '1';
        else
            inputsize = 64 - UInt(TCR_EL2.T1SZ);
            largegrain = TCR_EL2.TG1 == '11';       // TG1 and TG0 encodings differ
            midgrain = TCR_EL2.TG1 == '01';
            inputsize_max = if Have52BitVAExt() && largegrain then 52 else 48;
            inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 4
            if inputsize < inputsize_min then
                c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
                assert c IN {Constraint_FORCE, Constraint_FAULT};
                if c == Constraint_FORCE then inputsize = inputsize_min;
            basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsOnes(inputaddr<
            disabled = TCR_EL2.EPD1 == '1' || (PSTATE.EL == EL0 && HaveE0PDExt() && TCR_EL2.E0PD1 ==
            baseregister = TTBR1_EL2;
            descaddr.memattrs = WalkAttrDecode(TCR_EL2.SH1, TCR_EL2.ORGN1, TCR_EL2.IRGN1, secondstage
            hierattrsdisabled = AArch64.HaveHPDExt() && TCR_EL2.HPD1 == '1';
        ps = TCR_EL2.IPS;
        reversedescriptors = SCTLR_EL2.EE == '1';
        lookupsecure = if IsSecureEL2Enabled() then IsSecure() else FALSE;
        singlepriv = FALSE;
        update_AF = HaveAccessFlagUpdateExt() && TCR_EL2.HA == '1';
        update_AP = HaveDirtyBitModifierExt() && update_AF && TCR_EL2.HD == '1';
    elsif el == EL2 then
        inputsize = 64 - UInt(TCR_EL2.T0SZ);
        largegrain = TCR_EL2.TG0 == '01';
        midgrain = TCR_EL2.TG0 == '10';
        inputsize_max = if Have52BitVAExt() && largegrain then 52 else 48;
        inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 48);
        if inputsize < inputsize_min then
            c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
            assert c IN {Constraint_FORCE, Constraint_FAULT};
            if c == Constraint_FORCE then inputsize = inputsize_min;
        ps = TCR_EL2.PS;
        basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsZero(inputaddr<top:
        disabled = FALSE;
        baseregister = TTBR0_EL2;
        descaddr.memattrs = WalkAttrDecode(TCR_EL2.SH0, TCR_EL2.ORGN0, TCR_EL2.IRGN0, secondstage);
        reversedescriptors = SCTLR_EL2.EE == '1';
        lookupsecure = if IsSecureEL2Enabled() then IsSecure() else FALSE;
        singlepriv = TRUE;
        update_AF = HaveAccessFlagUpdateExt() && TCR_EL2.HA == '1';
        update_AP = HaveDirtyBitModifierExt() && update_AF && TCR_EL2.HD == '1';
        hierattrsdisabled = AArch64.HaveHPDExt() && TCR_EL2.HPD == '1';
    else
        if inputaddr<top> == '0' then
            inputsize = 64 - UInt(TCR_EL1.T0SZ);
            largegrain = TCR_EL1.TG0 == '01';
            midgrain = TCR_EL1.TG0 == '10';
            inputsize_max = if Have52BitVAExt() && largegrain then 52 else 48;
            inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 4
            if inputsize < inputsize_min then
                c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
                assert c IN {Constraint_FORCE, Constraint_FAULT};
                if c == Constraint_FORCE then inputsize = inputsize_min;
            basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsZero(inputaddr<
            disabled = TCR_EL1.EPD0 == '1' || (PSTATE.EL == EL0 && HaveE0PDExt() && TCR_EL1.E0PD0 ==
            disabled = disabled || (el == EL0 && acctype == AccType_NONFAULT && TCR_EL1.NFD0 == '1');
            baseregister = TTBR0_EL1;
            descaddr.memattrs = WalkAttrDecode(TCR_EL1.SH0, TCR_EL1.ORGN0, TCR_EL1.IRGN0, secondstage
            hierattrsdisabled = AArch64.HaveHPDExt() &&  TCR_EL1.HPD0 == '1';
        else
            inputsize = 64 - UInt(TCR_EL1.T1SZ);
            largegrain = TCR_EL1.TG1 == '11';       // TG1 and TG0 encodings differ
            midgrain = TCR_EL1.TG1 == '01';
            inputsize_max = if Have52BitVAExt() && largegrain then 52 else 48;
            inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 4
```

```
            if inputsize < inputsize_min then
                c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
                assert c IN {Constraint_FORCE, Constraint_FAULT};
                if c == Constraint_FORCE then inputsize = inputsize_min;
            basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsOnes(inputaddr<
            disabled = TCR_EL1.EPD1 == '1' || (PSTATE.EL == EL0 && HaveE0PDExt() && TCR_EL1.E0PD1 ==
            disabled = disabled || (el == EL0 && acctype == AccType_NONFAULT && TCR_EL1.NFD1 == '1');
            baseregister = TTBR1_EL1;
            descaddr.memattrs = WalkAttrDecode(TCR_EL1.SH1, TCR_EL1.ORGN1, TCR_EL1.IRGN1, secondstage
            hierattrsdisabled = AArch64.HaveHPDExt() &&  TCR_EL1.HPD1 == '1';
        ps = TCR_EL1.IPS;
        reversedescriptors = SCTLR_EL1.EE == '1';
        lookupsecure = IsSecure();
        singlepriv = FALSE;
        update_AF = HaveAccessFlagUpdateExt() && TCR_EL1.HA == '1';
        update_AP = HaveDirtyBitModifierExt() && update_AF && TCR_EL1.HD == '1';
    if largegrain then
        grainsize = 16;                                             // Log2(64KB page size)
        firstblocklevel = (if Have52BitPAExt() then 1 else 2);      // Largest block is 4TB (2^42 byt
                                                                    // and 512MB (2^29 bytes) otherwi
    elsif midgrain then
        grainsize = 14;                                             // Log2(16KB page size)
        firstblocklevel = 2;                                        // Largest block is 32MB (2^25 by
    else // Small grain
        grainsize = 12;                                             // Log2(4KB page size)
        firstblocklevel = 1;                                        // Largest block is 1GB (2^30 byt
    stride = grainsize - 3;                                         // Log2(page size / 8 bytes)
    // The starting level is the number of strides needed to consume the input address
    level = 4 - (1 + (inputsize - grainsize - 1) DIV stride);

else
    // Second stage translation
    inputaddr =       level = 4 - RoundUp(Real(inputsize - grainsize) / Real(stride));

else
    // Second stage translation
    inputaddr = ZeroExtend(ipaddress);
    if IsSecureBelowEL3() then
        // Second stage for Secure translation regime
        if s1_nonsecure then            // Non-secure IPA space
            t0size = VTCR_EL2.T0SZ;
            tg0    = VTCR_EL2.TG0;
            nswalk = VTCR_EL2.NSW;
        else                            // Secure IPA space
            t0size = VSTCR_EL2.T0SZ;
            tg0    = VSTCR_EL2.TG0;
            nswalk = VSTCR_EL2.SW;

        // Stage 2 translation accesses the Non-secure PA space or the Secure PA space
        if nswalk == '1' then
            // When walk is Non-secure, access must be to the Non-secure PA space
            nsaccess = '1';
        elsif !s1_nonsecure then
            // When walk is Secure and in the Secure IPA space,
            //  access is specified by VSTCR_EL2.SA
            nsaccess = VSTCR_EL2.SA;
        elsif VSTCR_EL2.SW == '1' || VSTCR_EL2.SA == '1' then
            // When walk is Secure and in the Non-secure IPA space,
            //  access is Non-secure when VSTCR_EL2.SA specifies the Non-secure PA space
            nsaccess = '1';
        else
            // When walk is Secure and in the Non-secure IPA space,
            //  if VSTCR_EL2.SA specifies the Secure PA space, access is specified by VTCR_EL2.NSA
            nsaccess = VTCR_EL2.NSA;
    else
        // Second stage for Non-secure translation regime
        t0size       = VTCR_EL2.T0SZ;
        tg0          = VTCR_EL2.TG0;
        nswalk       = '1';
        nsaccess     = '1';
```

```
    inputsize  = 64 - UInt(t0size);
    largegrain = tg0 == '01';
    midgrain   = tg0 == '10';

    inputsize_max = if Have52BitPAExt() && PAMax() == 52 && largegrain then 52 else 48;
    inputsize_min = 64 - (if !HaveSmallPageTblExt() then 39 else if largegrain then 47 else 48);
    if inputsize < inputsize_min then
        c = ConstrainUnpredictable(Unpredictable_RESTnSZ);
        assert c IN {Constraint_FORCE, Constraint_FAULT};
        if c == Constraint_FORCE then inputsize = inputsize_min;
    ps = VTCR_EL2.PS;
    basefound = inputsize >= inputsize_min && inputsize <= inputsize_max && IsZero(inputaddr<63:input
    disabled = FALSE;
    descaddr.memattrs = WalkAttrDecode(VTCR_EL2.SH0, VTCR_EL2.ORGN0, VTCR_EL2.IRGN0, secondstage);
    reversedescriptors = SCTLR_EL2.EE == '1';
    singlepriv = TRUE;
    update_AF = HaveAccessFlagUpdateExt() && VTCR_EL2.HA == '1';
    update_AP = HaveDirtyBitModifierExt() && update_AF && VTCR_EL2.HD == '1';

    if IsSecureEL2Enabled() then
        lookupsecure = !s1_nonsecure;
    else
        lookupsecure = FALSE;

    if lookupsecure then
        baseregister = VSTTBR_EL2;
        startlevel   = UInt(VSTCR_EL2.SL0);
    else
        baseregister = VTTBR_EL2;
        startlevel   = UInt(VTCR_EL2.SL0);
    if largegrain then
        grainsize = 16;                                         // Log2(64KB page size)
        level = 3 - startlevel;
        firstblocklevel = (if Have52BitPAExt() then 1 else 2);  // Largest block is 4TB (2^42 bytes)
                                                                // and 512MB (2^29 bytes) otherwise
    elsif midgrain then
        grainsize = 14;                                         // Log2(16KB page size)
        level = 3 - startlevel;
        firstblocklevel = 2;                                    // Largest block is 32MB (2^25 bytes)
    else // Small grain
        grainsize = 12;                                         // Log2(4KB page size)
        if HaveSmallPageTblExt() && startlevel == 3 then
            level = startlevel;                                 // Startlevel 3 (VTCR_EL2.SL0 or VSCTR_EL
        else
            level = 2 - startlevel;
        firstblocklevel = 1;                                    // Largest block is 1GB (2^30 bytes)
    stride = grainsize - 3;                                     // Log2(page size / 8 bytes)

    // Limits on IPA controls based on implemented PA size. Level 0 is only
    // supported by small grain translations
    if largegrain then                                  // 64KB pages
        // Level 1 only supported if implemented PA size is greater than 2^42 bytes
        if level == 0 || (level == 1 && PAMax() <= 42) then basefound = FALSE;
    elsif midgrain then                                 // 16KB pages
        // Level 1 only supported if implemented PA size is greater than 2^40 bytes
        if level == 0 || (level == 1 && PAMax() <= 40) then basefound = FALSE;
    else                                                // Small grain, 4KB pages
        // Level 0 only supported if implemented PA size is greater than 2^42 bytes
        if level < 0 || (level == 0 && PAMax() <= 42) then basefound = FALSE;

    // If the inputsize exceeds the PAMax value, the behavior is CONSTRAINED UNPREDICTABLE
    inputsizecheck = inputsize;
    if inputsize > PAMax() && (!ELUsingAArch32(EL1) || inputsize > 40) then
        case ConstrainUnpredictable(Unpredictable_LARGEIPA) of
            when Constraint_FORCE
                // Restrict the inputsize to the PAMax value
                inputsize = PAMax();
                inputsizecheck = PAMax();
            when Constraint_FORCENOSLCHECK
```

```
                // As FORCE, except use the configured inputsize in the size checks below
                inputsize = PAMax();
            when Constraint_FAULT
                // Generate a translation fault
                basefound = FALSE;
            otherwise
                Unreachable();

    // Number of entries in the starting level table =
    //     (Size of Input Address)/((Address per level)^(Num levels remaining)*(Size of Table))
    startsizecheck = inputsizecheck - ((3 - level)*stride + grainsize); // Log2(Num of entries)

    // Check for starting level table with fewer than 2 entries or longer than 16 pages.
    // Lower bound check is:  startsizecheck < Log2(2 entries)
    // Upper bound check is:  startsizecheck > Log2(pagesize/8*16)
    if startsizecheck < 1 || startsizecheck > stride + 4 then basefound = FALSE;

if !basefound || disabled then
    level = 0;           // AArch32 reports this as a level 1 fault
    result.addrdesc.fault = AArch64.TranslationFault(ipaddress, s1_nonsecure,  level, acctype, iswrit
                                                     secondstage, s2fs1walk);
    return result;

case ps of
    when '000'  outputsize = 32;
    when '001'  outputsize = 36;
    when '010'  outputsize = 40;
    when '011'  outputsize = 42;
    when '100'  outputsize = 44;
    when '101'  outputsize = 48;
    when '110'  outputsize = (if Have52BitPAExt() && largegrain then 52 else 48);
    otherwise   outputsize = integer IMPLEMENTATION_DEFINED "Reserved Intermediate Physical Address s

if outputsize > PAMax() then outputsize = PAMax();

if outputsize < 48 && !IsZero(baseregister<47:outputsize>) then
    level = 0;
    result.addrdesc.fault = AArch64.AddressSizeFault(ipaddress,s1_nonsecure,  level, acctype, iswrite
                                                     secondstage, s2fs1walk);
    return result;

// Bottom bound of the Base address is:
//     Log2(8 bytes per entry)+Log2(Number of entries in starting level table)
// Number of entries in starting level table =
//     (Size of Input Address)/((Address per level)^(Num levels remaining)*(Size of Table))
baselowerbound = 3 + inputsize - ((3-level)*stride + grainsize);  // Log2(Num of entries*8)
if outputsize == 52 then
    z = (if baselowerbound < 6 then 6 else baselowerbound);
    baseaddress = baseregister<5:2>:baseregister<47:z>:Zeros(z);
else
    baseaddress = ZeroExtend(baseregister<47:baselowerbound>:Zeros(baselowerbound));

ns_table = if lookupsecure then '0' else '1';
ap_table = '00';
xn_table = '0';
pxn_table = '0';

addrselecttop = inputsize - 1;

apply_nvnv1_effect = HaveNVExt() && EL2Enabled() && HCR_EL2.<NV,NV1> == '11' && S1TranslationRegime()
repeat
    addrselectbottom = (3-level)*stride + grainsize;

    bits(52) index = ZeroExtend(inputaddr<addrselecttop:addrselectbottom>:'000');
    descaddr.paddress.address = baseaddress OR index;
    descaddr.paddress.NS = if secondstage then nswalk else ns_table;

    // If there are two stages of translation, then the first stage table walk addresses
    // are themselves subject to translation
    if secondstage || !HasS2Translation() || (HaveNV2Ext() && acctype == AccType_NV2REGISTER) then
```

```
            descaddr2 = descaddr;
        else
            hwupdatewalk = FALSE;
            descaddr2 = AArch64.SecondStageWalk(descaddr, vaddress, acctype, iswrite, 8, hwupdatewalk);
            // Check for a fault on the stage 2 walk
            if IsFault(descaddr2) then
                result.addrdesc.fault = descaddr2.fault;
                return result;

        // Update virtual address for abort functions
        descaddr2.vaddress = ZeroExtend(vaddress);

        accdesc = CreateAccessDescriptorPTW(acctype, secondstage, s2fs1walk, level);
(vaddress);

        accdesc = CreateAccessDescriptorPTW(acctype, secondstage, s2fs1walk, level);
        desc = _Mem[descaddr2, 8, accdesc];

        if reversedescriptors then desc = BigEndianReverse(desc);

        if desc<0> == '0' || (desc<1:0> == '01' && (level == 3 ||
                                                    (HaveBlockBBM() && IsBlockDescriptorNTBitValid() && d
             // Fault (00), Reserved (10), Block (01) at level 3, or Block(01) with nT bit set.
            result.addrdesc.fault = AArch64.TranslationFault(ipaddress, s1_nonsecure, level, acctype,
                                                             iswrite, secondstage, s2fs1walk);
            return result;

        // Valid Block, Page, or Table entry
        if desc<1:0> == '01' || level == 3 then                 // Block (01) or Page (11)
            blocktranslate = TRUE;
        else                                                    // Table (11)
            if (outputsize < 52 && largegrain && !IsZero(desc<15:12>)) || (outputsize < 48 && !IsZero(des
                result.addrdesc.fault = AArch64.AddressSizeFault(ipaddress,s1_nonsecure,  level, acctype,
                                                                 iswrite, secondstage, s2fs1walk);
                return result;

            if outputsize == 52 then
                baseaddress = desc<15:12>:desc<47:grainsize>:Zeros(grainsize);
            else
                baseaddress = ZeroExtend(desc<47:grainsize>:Zeros(grainsize));
            if !secondstage then
                // Unpack the upper and lower table attributes
                ns_table    = ns_table    OR desc<63>;
            if !secondstage && !hierattrsdisabled then
                ap_table<1> = ap_table<1> OR desc<62>;       // read-only

                if apply_nvnv1_effect then
                    pxn_table   = pxn_table   OR desc<60>;
                else
                    xn_table    = xn_table    OR desc<60>;
                // pxn_table and ap_table[0] apply in EL1&0 or EL2&0 translation regimes
                if !singlepriv then
                    if !apply_nvnv1_effect then
                        pxn_table   = pxn_table   OR desc<59>;
                        ap_table<0> = ap_table<0> OR desc<61>;   // privileged

            level = level + 1;
            addrselecttop = addrselectbottom - 1;
            blocktranslate = FALSE;
    until blocktranslate;

    // Check block size is supported at this level
    if level < firstblocklevel then
        result.addrdesc.fault = AArch64.TranslationFault(ipaddress, s1_nonsecure, level, acctype,
                                                         iswrite, secondstage, s2fs1walk);
        return result;

    // Check for misprogramming of the contiguous bit
    if largegrain then
        contiguousbitcheck = level == 2 && inputsize < 34;
```

```
elsif midgrain then
    contiguousbitcheck = level == 2 && inputsize < 30;
else
    contiguousbitcheck = level == 1 && inputsize < 34;

if contiguousbitcheck && desc<52> == '1' then
    if boolean IMPLEMENTATION_DEFINED "Translation fault on misprogrammed contiguous bit" then
        result.addrdesc.fault = AArch64.TranslationFault(ipaddress, s1_nonsecure, level, acctype,
                                                         iswrite, secondstage, s2fs1walk);
        return result;

// Unpack the descriptor into address and upper and lower block attributes
if largegrain then
    outputaddress = desc<15:12>:desc<47:addrselectbottom>:inputaddr<addrselectbottom-1:0>;
else
    outputaddress = ZeroExtend(desc<47:addrselectbottom>:inputaddr<addrselectbottom-1:0>);

// When 52-bit PA is supported, for 64 Kbyte translation granule,
// block size might be larger than the supported output address size
if outputsize < 52 && !IsZero(outputaddress<51:outputsize>) then
    result.addrdesc.fault = AArch64.AddressSizeFault(ipaddress,s1_nonsecure,  level, acctype,
                                                     iswrite, secondstage, s2fs1walk);
    return result;

// Check Access Flag
if desc<10> == '0' then
    if !update_AF then
        result.addrdesc.fault = AArch64.AccessFlagFault(ipaddress,s1_nonsecure,  level, acctype,
                                                        iswrite, secondstage, s2fs1walk);
        return result;
    else
        result.descupdate.AF = TRUE;

if update_AP && desc<51> == '1' then
    // If hw update of access permission field is configured consider AP[2] as '0' / S2AP[2] as '1'
    if !secondstage && desc<7> == '1' then
        desc<7> = '0';
        result.descupdate.AP = TRUE;
    elsif secondstage && desc<7> == '0' then
        desc<7> = '1';
        result.descupdate.AP = TRUE;

// Required descriptor if AF or AP[2]/S2AP[2] needs update
result.descupdate.descaddr = descaddr;

if apply_nvnv1_effect then
    pxn = desc<54>;                                     // Bit[54] of the block/page descriptor hol
    xn = '0';                                           // XN is '0'
    ap = desc<7>:'01';                                  // Bit[6] of the block/page descriptor is t
else
    xn = desc<54>;                                      // Bit[54] of the block/page descriptor hol
    pxn = desc<53>;                                     // Bit[53] of the block/page descriptor hol
    ap = desc<7:6>:'1';                                 // Bits[7:6] of the block/page descriptor h
contiguousbit = desc<52>;
nG = desc<11>;
sh = desc<9:8>;
mematttr = desc<5:2>;                                   // AttrIndx and NS bit in stage 1

result.domain = bits(4) UNKNOWN;                        // Domains not used
result.level = level;
result.blocksize = 2^((3-level)*stride + grainsize);

// Stage 1 translation regimes also inherit attributes from the tables
if !secondstage then
    result.perms.xn      = xn OR xn_table;
    result.perms.ap<2>   = ap<2> OR ap_table<1>;        // Force read-only
    // PXN, nG and AP[1] apply in EL1&0 or EL2&0 stage 1 translation regimes
    if !singlepriv then
        result.perms.ap<1> = ap<1> AND NOT(ap_table<0>);  // Force privileged only
        result.perms.pxn   = pxn OR pxn_table;
```

```
            // Pages from Non-secure tables are marked non-global in Secure EL1&0
            if IsSecure() then
                result.nG = nG OR ns_table;
            else
                result.nG = nG;
        else
            result.perms.ap<1> = '1';
            result.perms.pxn   = '0';
            result.nG          = '0';
        result.GP = desc<50>;                                   // Stage 1 block or pages might be guarded
        result.perms.ap<0>   = '1';
        result.addrdesc.memattrs = AArch64.S1AttrDecode(sh, memattr<2:0>, acctype);
        result.addrdesc.paddress.NS = memattr<3> OR ns_table;
    else
        result.perms.ap<2:1> = ap<2:1>;
        result.perms.ap<0>   = '1';
        result.perms.xn      = xn;
        if HaveExtendedExecuteNeverExt() then result.perms.xxn = desc<53>;
        result.perms.pxn     = '0';
        result.nG            = '0';
        if s2fs1walk then
            result.addrdesc.memattrs = S2AttrDecode(sh, memattr, AccType_PTW);
        else
            result.addrdesc.memattrs = S2AttrDecode(sh, memattr, acctype);
        result.addrdesc.paddress.NS = nsaccess;

    result.addrdesc.paddress.address = outputaddress;
    result.addrdesc.fault = AArch64.NoFault();
    result.contiguous = contiguousbit == '1';
    if HaveCommonNotPrivateTransExt() then result.CnP = baseregister<0>;

    return result;
```

Library pseudocode for shared/debug/ClearStickyErrors/ClearStickyErrors

```
// ClearStickyErrors()
// ===================

ClearStickyErrors()
    EDSCR.TXU = '0';            // Clear TX underrun flag
    EDSCR.RXO = '0';            // Clear RX overrun flag

    if Halted() then            // in Debug state
        EDSCR.ITO = '0';        // Clear ITR overrun flag

    // If halted and the ITR is not empty then it is UNPREDICTABLE whether the EDSCR.ERR is cleared.
    // The UNPREDICTABLE behavior also affects the instructions in flight, but this is not described
    // in the pseudocode.
    if Halted() && EDSCR.ITE == '0' && ConstrainUnpredictableBool(Unpredictable_CLEARERRITEZERO) then
        return;
    EDSCR.ERR = '0';            // Clear cumulative error flag

    return;
```

Library pseudocode for shared/debug/DebugTarget/DebugTarget

```
// DebugTarget()
// =============
// Returns the debug exception target Exception level

bits(2) DebugTarget()
    secure = IsSecure();
    return DebugTargetFrom(secure);
```

Library pseudocode for shared/debug/DebugTarget/DebugTargetFrom

```
// DebugTargetFrom()
// =================

bits(2) DebugTargetFrom(boolean secure)
    if HaveEL(EL2) && !secure then
        if ELUsingAArch32(EL2) then
            route_to_el2 = (HDCR.TDE == '1' || HCR.TGE == '1');
        else
            route_to_el2 = (MDCR_EL2.TDE == '1' || HCR_EL2.TGE == '1');
    else
        route_to_el2 = FALSE;

    if route_to_el2 then
        target = EL2;
    elsif HaveEL(EL3) && HighestELUsingAArch32() && secure then
        target = EL3;
    else
        target = EL1;

    return target;
```

Library pseudocode for shared/debug/DoubleLockStatus/DoubleLockStatus

```
// DoubleLockStatus()
// ==================
// Returns the state of the OS Double Lock.
//    FALSE if OSDLR_EL1.DLK == 0 or DBGPRCR_EL1.CORENPDRQ == 1 or the PE is in Debug state.
//    TRUE if OSDLR_EL1.DLK == 1 and DBGPRCR_EL1.CORENPDRQ == 0 and the PE is in Non-debug state.

boolean DoubleLockStatus()
    if !HaveDoubleLock() then
        return FALSE;
    elsif ELUsingAArch32(EL1) then
        return DBGOSDLR.DLK == '1' && DBGPRCR.CORENPDRQ == '0' && !Halted();
    else
        return OSDLR_EL1.DLK == '1' && DBGPRCR_EL1.CORENPDRQ == '0' && !Halted();
```

Library pseudocode for shared/debug/authentication/AllowExternalDebugAccess

```
// AllowExternalDebugAccess()
// ==========================
// Returns TRUE if an external debug interface access to the External debug registers
// is allowed, FALSE otherwise.

boolean AllowExternalDebugAccess()
    // The access may also be subject to OS Lock, power-down, etc.
    if HaveSecureExtDebugView() then
        return AllowExternalDebugAccess(IsAccessSecure());
    else
        return AllowExternalDebugAccess(ExternalSecureInvasiveDebugEnabled());

// AllowExternalDebugAccess()
// ==========================
// Returns TRUE if an external debug interface access to the External debug registers
// is allowed for the given Security state, FALSE otherwise.

boolean AllowExternalDebugAccess(boolean allow_secure)
    // The access may also be subject to OS Lock, power-down, etc.
    if HaveSecureExtDebugView() || ExternalInvasiveDebugEnabled() then
        if allow_secure then
            return TRUE;
        elsif HaveEL(EL3) then
            if ELUsingAArch32(EL3) then
                return SDCR.EDAD == '0';
            else
                return MDCR_EL3.EDAD == '0';
        else
            return !IsSecure();
    else
        return FALSE;
```

Library pseudocode for shared/debug/authentication/AllowExternalPMUAccess

```
// AllowExternalPMUAccess()
// ========================
// Returns TRUE if an external debug interface access to the PMU registers is allowed, FALSE otherwise.

boolean AllowExternalPMUAccess()
    // The access may also be subject to OS Lock, power-down, etc.
    if HaveSecureExtDebugView() then
        return AllowExternalPMUAccess(IsAccessSecure());
    else
        return AllowExternalPMUAccess(ExternalSecureNoninvasiveDebugEnabled());

// AllowExternalPMUAccess()
// ========================
// Returns TRUE if an external debug interface access to the PMU registers is allowed for the given
// Security state, FALSE otherwise.

boolean AllowExternalPMUAccess(boolean allow_secure)
    // The access may also be subject to OS Lock, power-down, etc.
    if HaveSecureExtDebugView() || ExternalNoninvasiveDebugEnabled() then
        if allow_secure then
            return TRUE;
        elsif HaveEL(EL3) then
            if ELUsingAArch32(EL3) then
                return SDCR.EPMAD == '0';
            else
                return MDCR_EL3.EPMAD == '0';
        else
            return !IsSecure();
    else
        return FALSE;
```

Library pseudocode for shared/debug/authentication/AllowExternalTraceAccess

```
// AllowExternalTraceAccess()
// ==========================
// Returns TRUE if an external Trace access to the Trace registers is allowed, FALSE otherwise.

boolean AllowExternalTraceAccess()
    if !HaveTraceBufferExtension() then
        return TRUE;
    else
        return AllowExternalTraceAccess(IsAccessSecure());

// AllowExternalTraceAccess()
// ==========================
// Returns TRUE if an external Trace access to the Trace registers is allowed for the
// given Security state, FALSE otherwise.

boolean AllowExternalTraceAccess(boolean access_is_secure)
    // The access may also be subject to OS lock, power-down, etc.
    if !HaveTraceBufferExtension() || access_is_secure then
        return TRUE;
    elsif HaveEL(EL3) then
        // External Trace access is not supported for EL3 using AArch32
        assert !ELUsingAArch32(EL3);

        return MDCR_EL3.ETAD == '0';
    else
        return !IsSecure();
```

Library pseudocode for shared/debug/authentication/Debug_authentication

```
signal DBGEN;
signal NIDEN;
signal SPIDEN;
signal SPNIDEN;
```

Library pseudocode for shared/debug/authentication/ExternalInvasiveDebugEnabled

```
// ExternalInvasiveDebugEnabled()
// ==============================
// The definition of this function is IMPLEMENTATION DEFINED.
// In the recommended interface, this function returns the state of the DBGEN signal.

boolean ExternalInvasiveDebugEnabled()
    return DBGEN == HIGH;
```

Library pseudocode for shared/debug/authentication/ExternalNoninvasiveDebugAllowed

```
// ExternalNoninvasiveDebugAllowed()
// =================================
// Returns TRUE if Trace and PC Sample-based Profiling are allowed

boolean ExternalNoninvasiveDebugAllowed()
    return (ExternalNoninvasiveDebugEnabled() &&
            (!IsSecure() || ExternalSecureNoninvasiveDebugEnabled() ||
             (ELUsingAArch32(EL1) && PSTATE.EL == EL0 && SDER.SUNIDEN == '1')));
```

Library pseudocode for shared/debug/authentication/ExternalNoninvasiveDebugEnabled

```
// ExternalNoninvasiveDebugEnabled()
// =================================
// This function returns TRUE if the ARMv8.4-Debug is implemented, otherwise this
// function is IMPLEMENTATION DEFINED.
// In the recommended interface, ExternalNoninvasiveDebugEnabled returns the state of the (DBGEN
// OR NIDEN) signal.

boolean ExternalNoninvasiveDebugEnabled()
    return !HaveNoninvasiveDebugAuth() || ExternalInvasiveDebugEnabled() || NIDEN == HIGH;
```

Library pseudocode for shared/debug/authentication/ExternalSecureInvasiveDebugEnabled

```
// ExternalSecureInvasiveDebugEnabled()
// ====================================
// The definition of this function is IMPLEMENTATION DEFINED.
// In the recommended interface, this function returns the state of the (DBGEN AND SPIDEN) signal.
// CoreSight allows asserting SPIDEN without also asserting DBGEN, but this is not recommended.

boolean ExternalSecureInvasiveDebugEnabled()
    if !HaveEL(EL3) && !IsSecure() then return FALSE;
    return ExternalInvasiveDebugEnabled() && SPIDEN == HIGH;
```

Library pseudocode for shared/debug/authentication/ExternalSecureNoninvasiveDebugEnabled

```
// ExternalSecureNoninvasiveDebugEnabled()
// =======================================
// This function returns the value of ExternalSecureInvasiveDebugEnabled() when ARMv8.4-Debug
// is implemented. Otherwise, the definition of this function is IMPLEMENTATION DEFINED.
// In the recommended interface, this function returns the state of the (DBGEN OR NIDEN) AND
// (SPIDEN OR SPNIDEN) signal.

boolean ExternalSecureNoninvasiveDebugEnabled()
    if !HaveEL(EL3) && !IsSecure() then return FALSE;
    if HaveNoninvasiveDebugAuth() then
        return ExternalNoninvasiveDebugEnabled() && (SPIDEN == HIGH || SPNIDEN == HIGH);
    else
        return ExternalSecureInvasiveDebugEnabled();
```

Library pseudocode for shared/debug/authentication/IsAccessSecure

```
// Returns TRUE when an access is Secure
boolean IsAccessSecure();
```

Library pseudocode for shared/debug/authentication/IsCorePowered

```
// Returns TRUE if the Core power domain is powered on, FALSE otherwise.
boolean IsCorePowered();
```

Library pseudocode for shared/debug/cti/CTI_SetEventLevel

```
// Set a Cross Trigger multi-cycle input event trigger to the specified level.
CTI_SetEventLevel(CrossTriggerIn id, signal level);
```

Library pseudocode for shared/debug/cti/CTI_SignalEvent

```
// Signal a discrete event on a Cross Trigger input event trigger.
CTI_SignalEvent(CrossTriggerIn id);
```

Library pseudocode for shared/debug/cti/CrossTrigger

```
enumeration CrossTriggerOut {CrossTriggerOut_DebugRequest, CrossTriggerOut_RestartRequest,
                             CrossTriggerOut_IRQ,          CrossTriggerOut_RSVD3,
                             CrossTriggerOut_TraceExtIn0,  CrossTriggerOut_TraceExtIn1,
                             CrossTriggerOut_TraceExtIn2,  CrossTriggerOut_TraceExtIn3};

enumeration CrossTriggerIn  {CrossTriggerIn_CrossHalt,     CrossTriggerIn_PMUOverflow,
                             CrossTriggerIn_RSVD2,         CrossTriggerIn_RSVD3,
                             CrossTriggerIn_TraceExtOut0,  CrossTriggerIn_TraceExtOut1,
                             CrossTriggerIn_TraceExtOut2,  CrossTriggerIn_TraceExtOut3};
```

Library pseudocode for shared/debug/dccanditr/CheckForDCCInterrupts

```
// CheckForDCCInterrupts()
// =======================

CheckForDCCInterrupts()
    commrx = (EDSCR.RXfull == '1');
    commtx = (EDSCR.TXfull == '0');

    // COMMRX and COMMTX support is optional and not recommended for new designs.
    // SetInterruptRequestLevel(InterruptID_COMMRX, if commrx then HIGH else LOW);
    // SetInterruptRequestLevel(InterruptID_COMMTX, if commtx then HIGH else LOW);

    // The value to be driven onto the common COMMIRQ signal.
    if ELUsingAArch32(EL1) then
        commirq = ((commrx && DBGDCCINT.RX == '1') ||
                   (commtx && DBGDCCINT.TX == '1'));
    else
        commirq = ((commrx && MDCCINT_EL1.RX == '1') ||
                   (commtx && MDCCINT_EL1.TX == '1'));
    SetInterruptRequestLevel(InterruptID_COMMIRQ, if commirq then HIGH else LOW);

    return;
```

Library pseudocode for shared/debug/dccanditr/DBGDTRRX_EL0

```
// DBGDTRRX_EL0[] (external write)
// ===============================
// Called on writes to debug register 0x08C.

DBGDTRRX_EL0[boolean memory_mapped] = bits(32) value

    if EDPRSR<6:5,0> != '001' then                      // Check DLK, OSLK and PU bits
        IMPLEMENTATION_DEFINED "signal slave-generated error";
        return;

    if EDSCR.ERR == '1' then return;                    // Error flag set: ignore write

    // The Software lock is OPTIONAL.
    if memory_mapped && EDLSR.SLK == '1' then return;   // Software lock locked: ignore write

    if EDSCR.RXfull == '1' || (Halted() && EDSCR.MA == '1' && EDSCR.ITE == '0') then
        EDSCR.RXO = '1';  EDSCR.ERR = '1';              // Overrun condition: ignore write
        return;

    EDSCR.RXfull = '1';
    DTRRX = value;

    if Halted() && EDSCR.MA == '1' then
        EDSCR.ITE = '0';                            // See comments in EDITR[] (external write)
        if !UsingAArch32() then
            ExecuteA64(0xD5330501<31:0>);               // A64 "MRS X1,DBGDTRRX_EL0"
            ExecuteA64(0xB8004401<31:0>);               // A64 "STR W1,[X0],#4"
            X[1] = bits(64) UNKNOWN;
        else
            ExecuteT32(0xEE10<15:0> /*hw1*/, 0x1E15<15:0> /*hw2*/);  // T32 "MRS R1,DBGDTRRXint"
            ExecuteT32(0xF840<15:0> /*hw1*/, 0x1B04<15:0> /*hw2*/);  // T32 "STR R1,[R0],#4"
            R[1] = bits(32) UNKNOWN;
        // If the store aborts, the Data Abort exception is taken and EDSCR.ERR is set to 1
        if EDSCR.ERR == '1' then
            EDSCR.RXfull = bit UNKNOWN;
            DBGDTRRX_EL0 = bits(32) UNKNOWN;
        else
            // "MRS X1,DBGDTRRX_EL0" calls DBGDTR_EL0[] (read) which clears RXfull.
            assert EDSCR.RXfull == '0';

        EDSCR.ITE = '1';                                // See comments in EDITR[] (external write)
    return;

// DBGDTRRX_EL0[] (external read)
// ==============================

bits(32) DBGDTRRX_EL0[boolean memory_mapped]
    return DTRRX;
```

Library pseudocode for shared/debug/dccanditr/DBGDTRTX_EL0

```
// DBGDTRTX_EL0[] (external read)
// ==============================
// Called on reads of debug register 0x080.

bits(32) DBGDTRTX_EL0[boolean memory_mapped]

    if EDPRSR<6:5,0> != '001' then                      // Check DLK, OSLK and PU bits
        IMPLEMENTATION_DEFINED "signal slave-generated error";
        return bits(32) UNKNOWN;

    underrun = EDSCR.TXfull == '0' || (Halted() && EDSCR.MA == '1' && EDSCR.ITE == '0');
    value = if underrun then bits(32) UNKNOWN else DTRTX;

    if EDSCR.ERR == '1' then return value;              // Error flag set: no side-effects

    // The Software lock is OPTIONAL.
    if memory_mapped && EDLSR.SLK == '1' then           // Software lock locked: no side-effects
        return value;

    if underrun then
        EDSCR.TXU = '1';  EDSCR.ERR = '1';              // Underrun condition: block side-effects
        return value;                                   // Return UNKNOWN

    EDSCR.TXfull = '0';
    if Halted() && EDSCR.MA == '1' then
        EDSCR.ITE = '0';                                // See comments in EDITR[] (external write)

        if !UsingAArch32() then
            ExecuteA64(0xB8404401<31:0>);               // A64 "LDR W1,[X0],#4"
        else
            ExecuteT32(0xF850<15:0> /*hw1*/, 0x1B04<15:0> /*hw2*/);      // T32 "LDR R1,[R0],#4"
        // If the load aborts, the Data Abort exception is taken and EDSCR.ERR is set to 1
        if EDSCR.ERR == '1' then
            EDSCR.TXfull = bit UNKNOWN;
            DBGDTRTX_EL0 = bits(32) UNKNOWN;
        else
            if !UsingAArch32() then
                ExecuteA64(0xD5130501<31:0>);           // A64 "MSR DBGDTRTX_EL0,X1"
            else
                ExecuteT32(0xEE00<15:0> /*hw1*/, 0x1E15<15:0> /*hw2*/);  // T32 "MSR DBGDTRTXint,R1"
            // "MSR DBGDTRTX_EL0,X1" calls DBGDTR_EL0[] (write) which sets TXfull.
            assert EDSCR.TXfull == '1';
        if !UsingAArch32() then
            X[1] = bits(64) UNKNOWN;
        else
            R[1] = bits(32) UNKNOWN;
        EDSCR.ITE = '1';                                // See comments in EDITR[] (external write)

    return value;

// DBGDTRTX_EL0[] (external write)
// ===============================

DBGDTRTX_EL0[boolean memory_mapped] = bits(32) value
    // The Software lock is OPTIONAL.
    if memory_mapped && EDLSR.SLK == '1' then return;   // Software lock locked: ignore write
    DTRTX = value;
    return;
```

Library pseudocode for shared/debug/dccanditr/DBGDTR_EL0

```
// DBGDTR_EL0[] (write)
// ===================
// System register writes to DBGDTR_EL0, DBGDTRTX_EL0 (AArch64) and DBGDTRTXint (AArch32)

DBGDTR_EL0[] = bits(N) value
    // For MSR DBGDTRTX_EL0,<Rt>  N=32, value=X[t]<31:0>, X[t]<63:32> is ignored
    // For MSR DBGDTR_EL0,<Xt>    N=64, value=X[t]<63:0>
    assert N IN {32,64};
    if EDSCR.TXfull == '1' then
        value = bits(N) UNKNOWN;
    // On a 64-bit write, implement a half-duplex channel
    if N == 64 then DTRRX = value<63:32>;
    DTRTX = value<31:0>;        // 32-bit or 64-bit write
    EDSCR.TXfull = '1';
    return;

// DBGDTR_EL0[] (read)
// ===================
// System register reads of DBGDTR_EL0, DBGDTRRX_EL0 (AArch64) and DBGDTRRXint (AArch32)

bits(N) DBGDTR_EL0[]
    // For MRS <Rt>,DBGDTRTX_EL0  N=32, X[t]=Zeros(32):result
    // For MRS <Xt>,DBGDTR_EL0    N=64, X[t]=result
    assert N IN {32,64};
    bits(N) result;
    if EDSCR.RXfull == '0' then
        result = bits(N) UNKNOWN;
    else
        // On a 64-bit read, implement a half-duplex channel
        // NOTE: the word order is reversed on reads with regards to writes
        if N == 64 then result<63:32> = DTRTX;
        result<31:0> = DTRRX;
    EDSCR.RXfull = '0';
    return result;
```

Library pseudocode for shared/debug/dccanditr/DTR

```
bits(32) DTRRX;
bits(32) DTRTX;
```

Library pseudocode for shared/debug/dccanditr/EDITR

```
// EDITR[] (external write)
// ========================
// Called on writes to debug register 0x084.

EDITR[boolean memory_mapped] = bits(32) value
    if EDPRSR<6:5,0> != '001' then                      // Check DLK, OSLK and PU bits
        IMPLEMENTATION_DEFINED "signal slave-generated error";
        return;

    if EDSCR.ERR == '1' then return;                    // Error flag set: ignore write

    // The Software lock is OPTIONAL.
    if memory_mapped && EDLSR.SLK == '1' then return;   // Software lock locked: ignore write

    if !Halted() then return;                           // Non-debug state: ignore write

    if EDSCR.ITE == '0' || EDSCR.MA == '1' then
        EDSCR.ITO = '1';  EDSCR.ERR = '1';              // Overrun condition: block write
        return;

    // ITE indicates whether the processor is ready to accept another instruction; the processor
    // may support multiple outstanding instructions. Unlike the "InstrCompl" flag in [v7A] there
    // is no indication that the pipeline is empty (all instructions have completed). In this
    // pseudocode, the assumption is that only one instruction can be executed at a time,
    // meaning ITE acts like "InstrCompl".
    EDSCR.ITE = '0';

    if !UsingAArch32() then
        ExecuteA64(value);
    else
        ExecuteT32(value<15:0>/*hw1*/, value<31:16> /*hw2*/);

    EDSCR.ITE = '1';

    return;
```

Library pseudocode for shared/debug/halting/DCPSInstruction

```
// DCPSInstruction()
// =================
// Operation of the DCPS instruction in Debug state

DCPSInstruction(bits(2) target_el)

    SynchronizeContext();

    case target_el of
        when EL1
            if PSTATE.EL == EL2 || (PSTATE.EL == EL3 && !UsingAArch32()) then handle_el = PSTATE.EL;
            elsif EL2Enabled() && HCR_EL2.TGE == '1' then UndefinedFault();
            else handle_el = EL1;

        when EL2
            if !HaveEL(EL2) then UndefinedFault();
            elsif PSTATE.EL == EL3 && !UsingAArch32() then handle_el = EL3;
            elsif !IsSecureEL2Enabled() && IsSecure() then UndefinedFault();
            else handle_el = EL2;
        when EL3
            if EDSCR.SDD == '1' || !HaveEL(EL3) then UndefinedFault();
            handle_el = EL3;
        otherwise
            Unreachable();

    from_secure = IsSecure();
    if ELUsingAArch32(handle_el) then
        if PSTATE.M == M32_Monitor then SCR.NS = '0';
        assert UsingAArch32();                  // Cannot move from AArch64 to AArch32
        case handle_el of
            when EL1AArch32.WriteMode(M32_Svc);
                if HavePANExt() && SCTLR.SPAN == '0' then
                    PSTATE.PAN = '1';
            when EL2  AArch32.WriteMode(M32_Hyp);
            when EL3AArch32.WriteMode(M32_Monitor);
                if HavePANExt() then
                    if !from_secure then
                        PSTATE.PAN = '0';
                    elsif SCTLR.SPAN == '0' then
                        PSTATE.PAN = '1';
        if handle_el == EL2 then
            ELR_hyp = bits(32) UNKNOWN;  HSR = bits(32) UNKNOWN;
        else
            LR = bits(32) UNKNOWN;
        SPSR[] = bits(32) UNKNOWN;
        PSTATE.E = SCTLR[].EE;
        DLR = bits(32) UNKNOWN;  DSPSR = bits(32) UNKNOWN;

    else                                        // Targeting AArch64
        if UsingAArch32() then
            AArch64.MaybeZeroRegisterUppers();
        MaybeZeroSVEUppers(target_el);
        PSTATE.nRW = '0';  PSTATE.SP = '1';  PSTATE.EL = handle_el;
        if HavePANExt() && ((handle_el == EL1 && SCTLR_EL1.SPAN == '0') ||
                            (handle_el == EL2 && HCR_EL2.E2H == '1' &&
                            HCR_EL2.TGE == '1' && SCTLR_EL2.SPAN == '0')) then
            PSTATE.PAN = '1';
        ELR[] = bits(64) UNKNOWN;  SPSR[] = bits(32) UNKNOWN;  ESR[] = bits(32) UNKNOWN;
        DLR_EL0 = bits(64) UNKNOWN;  DSPSR_EL0 = bits(32) UNKNOWN;
        if HaveUAOExt() then PSTATE.UAO = '0';

    UpdateEDSCRFields();                        // Update EDSCR PE state flags
    sync_errors = HaveIESB() && SCTLR[].IESB == '1';
    if HaveDoubleFaultExt() && !UsingAArch32() then
        sync_errors = sync_errors || (SCR_EL3.EA == '1' && SCR_EL3.NMEA == '1' && PSTATE.EL == EL3);
    // SCTLR[].IESB might be ignored in Debug state.
    if !ConstrainUnpredictableBool(Unpredictable_IESBinDebug) then
        sync_errors = FALSE;
    if sync_errors then
```

```
        SynchronizeErrors();
    return;
```

Library pseudocode for shared/debug/halting/DRPSInstruction

```
// DRPSInstruction()
// =================
// Operation of the A64 DRPS and T32 ERET instructions in Debug state

DRPSInstruction()

    SynchronizeContext();

    sync_errors = HaveIESB() && SCTLR[].IESB == '1';
    if HaveDoubleFaultExt() && !UsingAArch32() then
        sync_errors = sync_errors || (SCR_EL3.EA == '1' && SCR_EL3.NMEA == '1' && PSTATE.EL == EL3);
    // SCTLR[].IESB might be ignored in Debug state.
    if !ConstrainUnpredictableBool(Unpredictable_IESBinDebug) then
        sync_errors = FALSE;
    if sync_errors then
        SynchronizeErrors();

    SetPSTATEFromPSR(SPSR[]);

    // PSTATE.{N,Z,C,V,Q,GE,SS,D,A,I,F} are not observable and ignored in Debug state, so
    // behave as if UNKNOWN.
    if UsingAArch32() then
        PSTATE.<N,Z,C,V,Q,GE,SS,A,I,F> = bits(13) UNKNOWN;
        //  In AArch32, all instructions are T32 and unconditional.
        PSTATE.IT = '00000000';  PSTATE.T = '1';        // PSTATE.J is RES0
        DLR = bits(32) UNKNOWN;  DSPSR = bits(32) UNKNOWN;
    else
        PSTATE.<N,Z,C,V,SS,D,A,I,F> = bits(9) UNKNOWN;
        DLR_EL0 = bits(64) UNKNOWN;  DSPSR_EL0 = bits(32) UNKNOWN;

    UpdateEDSCRFields();                                // Update EDSCR PE state flags

    return;
```

Library pseudocode for shared/debug/halting/DebugHalt

```
constant bits(6) DebugHalt_Breakpoint      = '000111';
constant bits(6) DebugHalt_EDBGRQ          = '010011';
constant bits(6) DebugHalt_Step_Normal     = '011011';
constant bits(6) DebugHalt_Step_Exclusive  = '011111';
constant bits(6) DebugHalt_OSUnlockCatch   = '100011';
constant bits(6) DebugHalt_ResetCatch      = '100111';
constant bits(6) DebugHalt_Watchpoint      = '101011';
constant bits(6) DebugHalt_HaltInstruction = '101111';
constant bits(6) DebugHalt_SoftwareAccess  = '110011';
constant bits(6) DebugHalt_ExceptionCatch  = '110111';
constant bits(6) DebugHalt_Step_NoSyndrome = '111011';
```

Library pseudocode for shared/debug/halting/DisableITRAndResumeInstructionPrefetch

```
DisableITRAndResumeInstructionPrefetch();
```

Library pseudocode for shared/debug/halting/ExecuteA64

```
// Execute an A64 instruction in Debug state.
ExecuteA64(bits(32) instr);
```

Library pseudocode for shared/debug/halting/ExecuteT32

```
// Execute a T32 instruction in Debug state.
ExecuteT32(bits(16) hw1, bits(16) hw2);
```

Library pseudocode for shared/debug/halting/ExitDebugState

```
// ExitDebugState()
// ================

ExitDebugState()
    assert Halted();
    SynchronizeContext();

    // Although EDSCR.STATUS signals that the PE is restarting, debuggers must use EDPRSR.SDR to
    // detect that the PE has restarted.
    EDSCR.STATUS = '000001';                            // Signal restarting
    EDESR<2:0> = '000';                                 // Clear any pending Halting debug events

    bits(64) new_pc;
    bits(32) spsr;

    if UsingAArch32() then
        new_pc = ZeroExtend(DLR);
        spsr = DSPSR;
    else
        new_pc = DLR_EL0;
        spsr = DSPSR_EL0;
    // If this is an illegal return, SetPSTATEFromPSR() will set PSTATE.IL.
    SetPSTATEFromPSR(spsr);                             // Can update privileged bits, even at EL0

    if UsingAArch32() then
        if ConstrainUnpredictableBool(Unpredictable_RESTARTALIGNPC) then new_pc<0> = '0';
        BranchTo(new_pc<31:0>, BranchType_DBGEXIT);     // AArch32 branch
    else
        // If targeting AArch32 then possibly zero the 32 most significant bits of the target PC
        if spsr<4> == '1' && ConstrainUnpredictableBool(Unpredictable_RESTARTZEROUPPERPC) then
            new_pc<63:32> = Zeros();
        BranchTo(new_pc, BranchType_DBGEXIT);           // A type of branch that is never predicted

    (EDSCR.STATUS,EDPRSR.SDR) = ('000010','1');         // Atomically signal restarted
    UpdateEDSCRFields();                                // Stop signalling PE state
    DisableITRAndResumeInstructionPrefetch();

    return;
```

Library pseudocode for shared/debug/halting/Halt

```
// Halt()
// ======

Halt(bits(6) reason)

    CTI_SignalEvent(CrossTriggerIn_CrossHalt);  // Trigger other cores to halt

    bits(64) preferred_restart_address = ThisInstrAddr();
    spsr = GetPSRFromPSTATE();

    if UsingAArch32() then
        // If entering from AArch32 state, spsr<21> is the DIT bit which has to be moved for DSPSR
        spsr<24> = spsr<21>;
        spsr<21> = PSTATE.SS;                    // Always save the SS bit

    if (HaveBTIExt() &&
        !(reason IN {DebugHalt_Step_Normal, DebugHalt_Step_Exclusive, DebugHalt_Step_NoSyndrome,
                     DebugHalt_Breakpoint, DebugHalt_HaltInstruction}) &&
        ConstrainUnpredictableBool(Unpredictable_ZEROBTYPE)) then
        DSPSR<11:10> = '00';

    if UsingAArch32() then
        DLR = preferred_restart_address<31:0>;
        DSPSR = spsr;
    else
        DLR_EL0 = preferred_restart_address;
        DSPSR_EL0 = spsr;

    EDSCR.ITE = '1';
    EDSCR.ITO = '0';
    if IsSecure() then
        EDSCR.SDD = '0';                         // If entered in Secure state, allow debug
    elsif HaveEL(EL3) then
        EDSCR.SDD = if ExternalSecureInvasiveDebugEnabled() then '0' else '1';
    else
        assert EDSCR.SDD == '1';                 // Otherwise EDSCR.SDD is RES1
    EDSCR.MA = '0';

    // PSTATE.{SS,D,A,I,F} are not observable and ignored in Debug state, so behave as if
    // UNKNOWN. PSTATE.{N,Z,C,V,Q,GE} are also not observable, but since these are not changed on
    // exception entry, this function also leaves them unchanged. PSTATE.{E,M,nRW,EL,SP} are
    // unchanged. PSTATE.IL is set to 0.
    if UsingAArch32() then
        PSTATE.<SS,A,I,F> = bits(4) UNKNOWN;
        //  In AArch32, all instructions are T32 and unconditional.
        PSTATE.IT = '00000000';
        PSTATE.T = '1';                          // PSTATE.J is RES0
    else
        PSTATE.<SS,D,A,I,F> = bits(5) UNKNOWN;
    PSTATE.IL = '0';

    StopInstructionPrefetchAndEnableITR();
    EDSCR.STATUS = reason;                       // Signal entered Debug state
    UpdateEDSCRFields();                         // Update EDSCR PE state flags.

    return;
```

Library pseudocode for shared/debug/halting/HaltOnBreakpointOrWatchpoint

```
// HaltOnBreakpointOrWatchpoint()
// ==============================
// Returns TRUE if the Breakpoint and Watchpoint debug events should be considered for Debug
// state entry, FALSE if they should be considered for a debug exception.

boolean HaltOnBreakpointOrWatchpoint()
    return HaltingAllowed() && EDSCR.HDE == '1' && OSLSR_EL1.OSLK == '0';
```

Library pseudocode for shared/debug/halting/Halted

```
// Halted()
// ========

boolean Halted()
    return !(EDSCR.STATUS IN {'000001', '000010'});                      // Halted
```

Library pseudocode for shared/debug/halting/HaltingAllowed

```
// HaltingAllowed()
// ================
// Returns TRUE if halting is currently allowed, FALSE if halting is prohibited.

boolean HaltingAllowed()
    if Halted() || DoubleLockStatus() then
        return FALSE;
    elsif IsSecure() then
        return ExternalSecureInvasiveDebugEnabled();
    else
        return ExternalInvasiveDebugEnabled();
```

Library pseudocode for shared/debug/halting/Restarting

```
// Restarting()
// ============

boolean Restarting()
    return EDSCR.STATUS == '000001';                                     // Restarting
```

Library pseudocode for shared/debug/halting/StopInstructionPrefetchAndEnableITR

```
StopInstructionPrefetchAndEnableITR();
```

Library pseudocode for shared/debug/halting/UpdateEDSCRFields

```
// UpdateEDSCRFields()
// ===================
// Update EDSCR PE state fields

UpdateEDSCRFields()

    if !Halted() then
        EDSCR.EL = '00';
        EDSCR.NS = bit UNKNOWN;
        EDSCR.RW = '1111';
    else
        EDSCR.EL = PSTATE.EL;
        EDSCR.NS = if IsSecure() then '0' else '1';

        bits(4) RW;
        RW<1> = if ELUsingAArch32(EL1) then '0' else '1';
        if PSTATE.EL != EL0 then
            RW<0> = RW<1>;
        else
            RW<0> = if UsingAArch32() then '0' else '1';
        if !HaveEL(EL2) || (HaveEL(EL3) && SCR_GEN[].NS == '0' && !IsSecureEL2Enabled()) then
            RW<2> = RW<1>;
        else
            RW<2> = if ELUsingAArch32(EL2) then '0' else '1';
        if !HaveEL(EL3) then
            RW<3> = RW<2>;
        else
            RW<3> = if ELUsingAArch32(EL3) then '0' else '1';

        // The least-significant bits of EDSCR.RW are UNKNOWN if any higher EL is using AArch32.
        if RW<3> == '0' then RW<2:0> = bits(3) UNKNOWN;
        elsif RW<2> == '0' then RW<1:0> = bits(2) UNKNOWN;
        elsif RW<1> == '0' then RW<0> = bit UNKNOWN;
        EDSCR.RW = RW;
    return;
```

Library pseudocode for shared/debug/haltingevents/CheckExceptionCatch

```
// CheckExceptionCatch()
// =====================
// Check whether an Exception Catch debug event is set on the current Exception level

CheckExceptionCatch(boolean exception_entry)
    // Called after an exception entry or exit, that is, such that IsSecure() and PSTATE.EL are correct
    // for the exception target.
    base = if IsSecure() then 0 else 4;
    if HaltingAllowed() then
        if HaveExtendedECDebugEvents() then
            exception_exit = !exception_entry;
            ctrl = EDECCR<UInt(PSTATE.EL) + base + 8>:EDECCR<UInt(PSTATE.EL) + base>;
            case ctrl of
                when '00'  halt = FALSE;
                when '01'  halt = TRUE;
                when '10'  halt = (exception_exit == TRUE);
                when '11'  halt = (exception_entry == TRUE);
        else
            halt = (EDECCR<UInt(PSTATE.EL) + base> == '1');
        if halt then Halt(DebugHalt_ExceptionCatch);
```

Library pseudocode for shared/debug/haltingevents/CheckHaltingStep

```
// CheckHaltingStep()
// ==================
// Check whether EDESR.SS has been set by Halting Step

CheckHaltingStep()
    if HaltingAllowed() && EDESR.SS == '1' then
        // The STATUS code depends on how we arrived at the state where EDESR.SS == 1.
        if HaltingStep_DidNotStep() then
            Halt(DebugHalt_Step_NoSyndrome);
        elsif HaltingStep_SteppedEX() then
            Halt(DebugHalt_Step_Exclusive);
        else
            Halt(DebugHalt_Step_Normal);
```

Library pseudocode for shared/debug/haltingevents/CheckOSUnlockCatch

```
// CheckOSUnlockCatch()
// ====================
// Called on unlocking the OS Lock to pend an OS Unlock Catch debug event

CheckOSUnlockCatch()
    if (    if EDECR.OSUCE == '1' && !HaveDoPD() && CTIDEVCTL.OSUCE == '1') || (!HaveDoPD() && EDECR.OSUC
        if !Halted() then EDESR.OSUC = '1';
```

Library pseudocode for shared/debug/haltingevents/CheckPendingOSUnlockCatch

```
// CheckPendingOSUnlockCatch()
// ===========================
// Check whether EDESR.OSUC has been set by an OS Unlock Catch debug event

CheckPendingOSUnlockCatch()
    if HaltingAllowed() && EDESR.OSUC == '1' then
        Halt(DebugHalt_OSUnlockCatch);
```

Library pseudocode for shared/debug/haltingevents/CheckPendingResetCatch

```
// CheckPendingResetCatch()
// ========================
// Check whether EDESR.RC has been set by a Reset Catch debug event

CheckPendingResetCatch()
    if HaltingAllowed() && EDESR.RC == '1' then
        Halt(DebugHalt_ResetCatch);
```

Library pseudocode for shared/debug/haltingevents/CheckResetCatch

```
// CheckResetCatch()
// =================
// Called after reset

CheckResetCatch()
    if (    if EDECR.RCE == '1' then
        EDESR.RC = '1';
        // If halting is allowed then halt immediately
        ifHaveDoPD() && CTIDEVCTL.RCE == '1') || (!HaveDoPD() && EDECR.RCE == '1') then
        EDESR.RC = '1';
        // If halting is allowed then halt immediately
        if HaltingAllowed() then Halt(DebugHalt_ResetCatch);
```

Library pseudocode for shared/debug/haltingevents/CheckSoftwareAccessToDebugRegisters

```
// CheckSoftwareAccessToDebugRegisters()
// =====================================
// Check for access to Breakpoint and Watchpoint registers.

CheckSoftwareAccessToDebugRegisters()
    os_lock = (if ELUsingAArch32(EL1) then DBGOSLSR.OSLK else OSLSR_EL1.OSLK);
    if HaltingAllowed() && EDSCR.TDA == '1' && os_lock == '0' then
        Halt(DebugHalt_SoftwareAccess);
```

Library pseudocode for shared/debug/haltingevents/ExternalDebugRequest

```
// ExternalDebugRequest()
// ======================

ExternalDebugRequest()
    if HaltingAllowed() then
        Halt(DebugHalt_EDBGRQ);
    // Otherwise the CTI continues to assert the debug request until it is taken.
```

Library pseudocode for shared/debug/haltingevents/HaltingStep_DidNotStep

```
// Returns TRUE if the previously executed instruction was executed in the inactive state, that is,
// if it was not itself stepped.
boolean HaltingStep_DidNotStep();
```

Library pseudocode for shared/debug/haltingevents/HaltingStep_SteppedEX

```
// Returns TRUE if the previously executed instruction was a Load-Exclusive class instruction
// executed in the active-not-pending state.
boolean HaltingStep_SteppedEX();
```

Library pseudocode for shared/debug/haltingevents/RunHaltingStep

```
// RunHaltingStep()
// ================

RunHaltingStep(boolean exception_generated, bits(2) exception_target, boolean syscall,
               boolean reset)
    // "exception_generated" is TRUE if the previous instruction generated a synchronous exception
    // or was cancelled by an asynchronous exception.
    //
    // if "exception_generated" is TRUE then "exception_target" is the target of the exception, and
    // "syscall" is TRUE if the exception is a synchronous exception where the preferred return
    // address is the instruction following that which generated the exception.
    //
    // "reset" is TRUE if exiting reset state into the highest EL.

    if reset then assert !Halted();             // Cannot come out of reset halted
    active = EDECR.SS == '1' && !Halted();

    if active && reset then                     // Coming out of reset with EDECR.SS set
        EDESR.SS = '1';
    elsif active && HaltingAllowed() then
        if exception_generated && exception_target == EL3 then
            advance = syscall || ExternalSecureInvasiveDebugEnabled();
        else
            advance = TRUE;
        if advance then EDESR.SS = '1';

    return;
```

Library pseudocode for shared/debug/interrupts/ExternalDebugInterruptsDisabled

```
// ExternalDebugInterruptsDisabled()
// =================================
// Determine whether EDSCR disables interrupts routed to 'target'

boolean ExternalDebugInterruptsDisabled(bits(2) target)
    case target of
        when EL3
            int_dis = EDSCR.INTdis == '11' && ExternalSecureInvasiveDebugEnabled();
        when EL2
            int_dis = EDSCR.INTdis == '1x' && ExternalInvasiveDebugEnabled();
        when EL1
            if IsSecure() then
                int_dis = EDSCR.INTdis == '1x' && ExternalSecureInvasiveDebugEnabled();
            else
                int_dis = EDSCR.INTdis != '00' && ExternalInvasiveDebugEnabled();
    return int_dis;
```

Library pseudocode for shared/debug/interrupts/InterruptID

```
enumeration InterruptID {InterruptID_PMUIRQ, InterruptID_COMMIRQ, InterruptID_CTIIRQ,
                         InterruptID_COMMRX, InterruptID_COMMTX};
```

Library pseudocode for shared/debug/interrupts/SetInterruptRequestLevel

```
// Set a level-sensitive interrupt to the specified level.
SetInterruptRequestLevel(InterruptID id, signal level);
```

Library pseudocode for shared/debug/samplebasedprofiling/CreatePCSample

```
// CreatePCSample()
// ================

CreatePCSample()
    // In a simple sequential execution of the program, CreatePCSample is executed each time the PE
    // executes an instruction that can be sampled. An implementation is not constrained such that
    // reads of EDPCSRlo return the current values of PC, etc.

    pc_sample.valid = ExternalNoninvasiveDebugAllowed() && !Halted();
    pc_sample.pc = ThisInstrAddr();
    pc_sample.el = PSTATE.EL;
    pc_sample.rw = if UsingAArch32() then '0' else '1';
    pc_sample.ns = if IsSecure() then '0' else '1';
    pc_sample.contextidr = if ELUsingAArch32(EL1) then CONTEXTIDR else CONTEXTIDR_EL1;
    pc_sample.has_el2 = EL2Enabled();

    if EL2Enabled() then
        if ELUsingAArch32(EL2) then
            pc_sample.vmid = ZeroExtend(VTTBR.VMID, 16);
        elsif !Have16bitVMID() || VTCR_EL2.VS == '0' then
            pc_sample.vmid = ZeroExtend(VTTBR_EL2.VMID<7:0>, 16);
        else
            pc_sample.vmid = VTTBR_EL2.VMID;
        if HaveVirtHostExt() && !ELUsingAArch32(EL2) then
            pc_sample.contextidr_el2 = CONTEXTIDR_EL2;
        else
            pc_sample.contextidr_el2 = bits(32) UNKNOWN;
        pc_sample.el0h = PSTATE.EL == EL0 && IsInHost();
    return;
```

Library pseudocode for shared/debug/samplebasedprofiling/EDPCSRlo

```
// EDPCSRlo[] (read)
// ================

bits(32) EDPCSRlo[boolean memory_mapped]

    if EDPRSR<6:5,0> != '001' then                      // Check DLK, OSLK and PU bits
        IMPLEMENTATION_DEFINED "signal slave-generated error";
        return bits(32) UNKNOWN;

    // The Software lock is OPTIONAL.
    update = !memory_mapped || EDLSR.SLK == '0';        // Software locked: no side-effects

    if pc_sample.valid then
        sample = pc_sample.pc<31:0>;
        if update then
            if HaveVirtHostExt() && EDSCR.SC2 == '1' then
                EDPCSRhi.PC = (if pc_sample.rw == '0' then Zeros(24) else pc_sample.pc<55:32>);
                EDPCSRhi.EL = pc_sample.el;
                EDPCSRhi.NS = pc_sample.ns;
            else
                EDPCSRhi = (if pc_sample.rw == '0' then Zeros(32) else pc_sample.pc<63:32>);
            EDCIDSR = pc_sample.contextidr;
            if HaveVirtHostExt() && EDSCR.SC2 == '1' then
                EDVIDSR = (if HaveEL(EL2) && pc_sample.ns == '1' then pc_sample.contextidr_el2
                           else bits(32) UNKNOWN);
            else
                if HaveEL(EL2) && pc_sample.ns == '1' && pc_sample.el IN {EL1,EL0} then
                    EDVIDSR.VMID = pc_sample.vmid;
                else
                    EDVIDSR.VMID = Zeros();
                EDVIDSR.NS = pc_sample.ns;
                EDVIDSR.E2 = (if pc_sample.el == EL2 then '1' else '0');
                EDVIDSR.E3 = (if pc_sample.el == EL3 then '1' else '0') AND pc_sample.rw;
                // The conditions for setting HV are not specified if PCSRhi is zero.
                // An example implementation may be "pc_sample.rw".
                EDVIDSR.HV = (if !IsZero(EDPCSRhi) then '1' else bit IMPLEMENTATION_DEFINED "0 or 1");
    else
        sample = Ones(32);
        if update then
            EDPCSRhi = bits(32) UNKNOWN;
            EDCIDSR = bits(32) UNKNOWN;
            EDVIDSR = bits(32) UNKNOWN;

    return sample;
```

Library pseudocode for shared/debug/samplebasedprofiling/PCSample

```
type PCSample is (
    boolean valid,
    bits(64) pc,
    bits(2) el,
    bit rw,
    bit ns,
    boolean has_el2,
    bits(32) contextidr,
    bits(32) contextidr_el2,
    boolean el0h,
    bits(16) vmid
)

PCSample pc_sample;
```

Library pseudocode for shared/debug/samplebasedprofiling/PMPCSR

```
// PMPCSR[] (read)
// ===============

bits(32) PMPCSR[boolean memory_mapped]

    if EDPRSR<6:5,0> != '001' then                      // Check DLK, OSLK and PU bits
        IMPLEMENTATION_DEFINED "signal slave-generated error";
        return bits(32) UNKNOWN;

    // The Software lock is OPTIONAL.
    update = !memory_mapped || PMLSR.SLK == '0';        // Software locked: no side-effects

    if pc_sample.valid then
        sample = pc_sample.pc<31:0>;
        if update then
            PMPCSR<55:32> = (if pc_sample.rw == '0' then Zeros(24) else pc_sample.pc<55:32>);
            PMPCSR.EL = pc_sample.el;
            PMPCSR.NS = pc_sample.ns;

            PMCID1SR = pc_sample.contextidr;
            PMCID2SR = if pc_sample.has_el2 then pc_sample.contextidr_el2 else bits(32) UNKNOWN;

            PMVIDSR.VMID = (if pc_sample.has_el2 && pc_sample.el IN {EL1,EL0} && !pc_sample.el0h
                            then pc_sample.vmid else bits(16) UNKNOWN);
    else
        sample = Ones(32);
        if update then
            PMPCSR<55:32>  = bits(24) UNKNOWN;
            PMPCSR.EL = bits(2) UNKNOWN;
            PMPCSR.NS = bit UNKNOWN;

            PMCID1SR = bits(32) UNKNOWN;
            PMCID2SR = bits(32) UNKNOWN;

            PMVIDSR.VMID = bits(16) UNKNOWN;

    return sample;
```

Library pseudocode for shared/debug/softwarestep/CheckSoftwareStep

```
// CheckSoftwareStep()
// ===================
// Take a Software Step exception if in the active-pending state

CheckSoftwareStep()

    // Other self-hosted debug functions will call AArch32.GenerateDebugExceptions() if called from
    // AArch32 state. However, because Software Step is only active when the debug target Exception
    // level is using AArch64, CheckSoftwareStep only calls AArch64.GenerateDebugExceptions().
    if !ELUsingAArch32(DebugTarget()) && AArch64.GenerateDebugExceptions() then
        if MDSCR_EL1.SS == '1' && PSTATE.SS == '0' then
            AArch64.SoftwareStepException();
```

Library pseudocode for shared/debug/softwarestep/DebugExceptionReturnSS

```
// DebugExceptionReturnSS()
// ========================
// Returns value to write to PSTATE.SS on an exception return or Debug state exit.

bit DebugExceptionReturnSS(bits(32) spsr)
    assert Halted() || Restarting() ||  PSTATE.EL != EL0;

    SS_bit = '0';

    if MDSCR_EL1.SS == '1' then
        if Restarting() then
            enabled_at_source = FALSE;
        elsif UsingAArch32() then
            enabled_at_source = AArch32.GenerateDebugExceptions();
        else
            enabled_at_source = AArch64.GenerateDebugExceptions();

        if IllegalExceptionReturn(spsr) then
            dest = PSTATE.EL;
        else
            (valid, dest) = ELFromSPSR(spsr);  assert valid;

        secure = IsSecureBelowEL3() || dest == EL3;
        if ELUsingAArch32(dest) then
            enabled_at_dest = AArch32.GenerateDebugExceptionsFrom(dest, secure);
        else
            mask = spsr<9>;
            enabled_at_dest = AArch64.GenerateDebugExceptionsFrom(dest, secure, mask);
        ELd = DebugTargetFrom(secure);
        if !ELUsingAArch32(ELd) && !enabled_at_source && enabled_at_dest then
            SS_bit = spsr<21>;
    return SS_bit;
```

Library pseudocode for shared/debug/softwarestep/SSAdvance

```
// SSAdvance()
// ===========
// Advance the Software Step state machine.

SSAdvance()

    // A simpler implementation of this function just clears PSTATE.SS to zero regardless of the
    // current Software Step state machine. However, this check is made to illustrate that the
    // processor only needs to consider advancing the state machine from the active-not-pending
    // state.
    target = DebugTarget();
    step_enabled = !ELUsingAArch32(target) && MDSCR_EL1.SS == '1';
    active_not_pending = step_enabled && PSTATE.SS == '1';

    if active_not_pending then PSTATE.SS = '0';

    return;
```

Library pseudocode for shared/debug/softwarestep/SoftwareStep_DidNotStep

```
// Returns TRUE if the previously executed instruction was executed in the inactive state, that is,
// if it was not itself stepped.
boolean SoftwareStep_DidNotStep();
```

Library pseudocode for shared/debug/softwarestep/SoftwareStep_SteppedEX

```
// Returns TRUE if the previously executed instruction was a Load-Exclusive class instruction
// executed in the active-not-pending state.
boolean SoftwareStep_SteppedEX();
```

Library pseudocode for shared/exceptions/exceptions/ConditionSyndrome

```
// ConditionSyndrome()
// ===================
// Return CV and COND fields of instruction syndrome

bits(5) ConditionSyndrome()

    bits(5) syndrome;

    if UsingAArch32() then
        cond = AArch32.CurrentCond();
        if PSTATE.T == '0' then             // A32
            syndrome<4> = '1';
            // A conditional A32 instruction that is known to pass its condition code check
            // can be presented either with COND set to 0xE, the value for unconditional, or
            // the COND value held in the instruction.
            if ConditionHolds(cond) && ConstrainUnpredictableBool(Unpredictable_ESRCONDPASS) then
                syndrome<3:0> = '1110';
            else
                syndrome<3:0> = cond;
        else                                // T32
            // When a T32 instruction is trapped, it is IMPLEMENTATION DEFINED whether:
            //  * CV set to 0 and COND is set to an UNKNOWN value
            //  * CV set to 1 and COND is set to the condition code for the condition that
            //    applied to the instruction.
            if boolean IMPLEMENTATION_DEFINED "Condition valid for trapped T32" then
                syndrome<4> = '1';
                syndrome<3:0> = cond;
            else
                syndrome<4> = '0';
                syndrome<3:0> = bits(4) UNKNOWN;
    else
        syndrome<4> = '1';
        syndrome<3:0> = '1110';

    return syndrome;
```

Library pseudocode for shared/exceptions/exceptions/Exception

```
enumeration Exception {Exception_Uncategorized,        // Uncategorized or unknown reason
                       Exception_WFxTrap,              // Trapped WFI or WFE instruction
                       Exception_CP15RTTrap,           // Trapped AArch32 MCR or MRC access to CP15
                       Exception_CP15RRTTrap,          // Trapped AArch32 MCRR or MRRC access to CP15
                       Exception_CP14RTTrap,           // Trapped AArch32 MCR or MRC access to CP14
                       Exception_CP14DTTrap,           // Trapped AArch32 LDC or STC access to CP14
                       Exception_AdvSIMDFPAccessTrap, // HCPTR-trapped access to SIMD or FP
                       Exception_FPIDTrap,             // Trapped access to SIMD or FP ID register
                       // Trapped BXJ instruction not supported in Armv8
                       Exception_PACTrap,              // Trapped invalid PAC use
                       Exception_CP14RRTTrap,          // Trapped MRRC access to CP14 from AArch32
                       Exception_IllegalState,         // Illegal Execution state
                       Exception_SupervisorCall,       // Supervisor Call
                       Exception_HypervisorCall,       // Hypervisor Call
                       Exception_MonitorCall,          // Monitor Call or Trapped SMC instruction
                       Exception_SystemRegisterTrap,  // Trapped MRS or MSR system register access
                       Exception_ERetTrap,             // Trapped invalid ERET use
                       Exception_InstructionAbort,     // Instruction Abort or Prefetch Abort
                       Exception_PCAlignment,          // PC alignment fault
                       Exception_DataAbort,            // Data Abort
                       Exception_NV2DataAbort,         // Data abort at EL1 reported as being from EL2
                       Exception_SPAlignment,          // SP alignment fault
                       Exception_FPTrappedException,  // IEEE trapped FP exception
                       Exception_SError,               // SError interrupt
                       Exception_Breakpoint,           // (Hardware) Breakpoint
                       Exception_SoftwareStep,         // Software Step
                       Exception_Watchpoint,           // Watchpoint
                       Exception_NV2Watchpoint,        // Watchpoint at EL1 reported as being from EL2Exce
                       Exception_SoftwareBreakpoint,  // Software Breakpoint InstructionException_VectorC
                       Exception_VectorCatch,          // AArch32 Vector CatchException_IRQ,
                       Exception_IRQ,                  // IRQ interruptException_SVEAccessTrap,        // H
                       Exception_SVEAccessTrap,        // HCPTR trapped access to SVEException_TSTARTAcces
                       Exception_TSTARTAccessTrap,     // Trapped TSTART accessException_BranchTarget,
                       Exception_BranchTarget,         // Branch Target IdentificationException_FIQ};
                       Exception_FIQ};                 // FIQ interrupt
```

Library pseudocode for shared/exceptions/exceptions/ExceptionRecord

```
type ExceptionRecord is (Exception exceptype,          // Exception class
                         bits(25)  syndrome,           // Syndrome record
                         bits(64)  vaddress,           // Virtual fault address
                         boolean   ipavalid,           // Physical fault address for second stage faults i
                         bits(1)   NS,                 // Physical fault address for second stage faults i
                         bits(52)  ipaddress)          // Physical fault address for second stage faults
```

Library pseudocode for shared/exceptions/exceptions/ExceptionSyndrome

```
// ExceptionSyndrome()
// ===================
// Return a blank exception syndrome record for an exception of the given type.

ExceptionRecord ExceptionSyndrome(Exception exceptype)

    ExceptionRecord r;

    r.exceptype = exceptype;

    // Initialize all other fields
    r.syndrome = Zeros();
    r.vaddress = Zeros();
    r.ipavalid = FALSE;
    r.NS = '0';
    r.ipaddress = Zeros();

    return r;
```

Library pseudocode for shared/exceptions/traps/ReservedValue

```
// ReservedValue()
// ===============

ReservedValue()
    if UsingAArch32() && !AArch32.GeneralExceptionsToAArch64() then
        AArch32.TakeUndefInstrException();
    else
        AArch64.UndefinedFault();
```

Library pseudocode for shared/exceptions/traps/UnallocatedEncoding

```
// UnallocatedEncoding()
// =====================

UnallocatedEncoding()
    if UsingAArch32() && AArch32.ExecutingCP10or11Instr() then
        FPEXC.DEX = '0';
    if UsingAArch32() && !AArch32.GeneralExceptionsToAArch64() then
        AArch32.TakeUndefInstrException();
    else
        AArch64.UndefinedFault();
```

Library pseudocode for shared/functions/aborts/EncodeLDFSC

```
// EncodeLDFSC()
// =============
// Function that gives the Long-descriptor FSC code for types of Fault

bits(6) EncodeLDFSC(Fault statuscode, integer level)

    bits(6) result;
    case statuscode of
        when Fault_AddressSize         result = '0000':level<1:0>; assert level IN {0,1,2,3};
        when Fault_AccessFlag          result = '0010':level<1:0>; assert level IN {1,2,3};
        when Fault_Permission          result = '0011':level<1:0>; assert level IN {1,2,3};
        when Fault_Translation         result = '0001':level<1:0>; assert level IN {0,1,2,3};
        when Fault_SyncExternal        result = '010000';
        when Fault_SyncExternalOnWalk  result = '0101':level<1:0>; assert level IN {0,1,2,3};
        when Fault_SyncParity          result = '011000';
        when Fault_SyncParityOnWalk    result = '0111':level<1:0>; assert level IN {0,1,2,3};
        when Fault_AsyncParity         result = '011001';
        when Fault_AsyncExternal       result = '010001';
        when Fault_Alignment           result = '100001';
        when Fault_Debug               result = '100010';
        when Fault_TLBConflict         result = '110000';
        when Fault_HWUpdateAccessFlag  result = '110001';
        when Fault_Lockdown            result = '110100';  // IMPLEMENTATION DEFINED
        when Fault_Exclusive           result = '110101';  // IMPLEMENTATION DEFINED
        otherwise                      Unreachable();

    return result;
```

Library pseudocode for shared/functions/aborts/IPAValid

```
// IPAValid()
// ==========
// Return TRUE if the IPA is reported for the abort

boolean IPAValid(FaultRecord fault)
    assert fault.statuscode != Fault_None;

    if fault.s2fs1walk then
        return fault.statuscode IN {Fault_AccessFlag, Fault_Permission, Fault_Translation,
                                    Fault_AddressSize};
    elsif fault.secondstage then
        return fault.statuscode IN {Fault_AccessFlag, Fault_Translation, Fault_AddressSize};
    else
        return FALSE;
```

Library pseudocode for shared/functions/aborts/IsAsyncAbort

```
// IsAsyncAbort()
// ==============
// Returns TRUE if the abort currently being processed is an asynchronous abort, and FALSE
// otherwise.

boolean IsAsyncAbort(Fault statuscode)
    assert statuscode != Fault_None;

    return (statuscode IN {Fault_AsyncExternal, Fault_AsyncParity});

// IsAsyncAbort()
// ==============

boolean IsAsyncAbort(FaultRecord fault)
    return IsAsyncAbort(fault.statuscode);
```

Library pseudocode for shared/functions/aborts/IsDebugException

```
// IsDebugException()
// ==================

boolean IsDebugException(FaultRecord fault)
    assert fault.statuscode != Fault_None;
    return fault.statuscode == Fault_Debug;
```

Library pseudocode for shared/functions/aborts/IsExternalAbort

```
// IsExternalAbort()
// =================
// Returns TRUE if the abort currently being processed is an external abort and FALSE otherwise.

boolean IsExternalAbort(Fault statuscode)
    assert statuscode != Fault_None;

    return (statuscode IN {Fault_SyncExternal, Fault_SyncParity, Fault_SyncExternalOnWalk, Fault_SyncPari
                      Fault_AsyncExternal, Fault_AsyncParity });

// IsExternalAbort()
// =================

boolean IsExternalAbort(FaultRecord fault)
    return IsExternalAbort(fault.statuscode);
```

Library pseudocode for shared/functions/aborts/IsExternalSyncAbort

```
// IsExternalSyncAbort()
// =====================
// Returns TRUE if the abort currently being processed is an external synchronous abort and FALSE otherwi

boolean IsExternalSyncAbort(Fault statuscode)
    assert statuscode != Fault_None;

    return (statuscode IN {Fault_SyncExternal, Fault_SyncParity, Fault_SyncExternalOnWalk, Fault_SyncPari

// IsExternalSyncAbort()
// =====================

boolean IsExternalSyncAbort(FaultRecord fault)
    return IsExternalSyncAbort(fault.statuscode);
```

Library pseudocode for shared/functions/aborts/IsFault

```
// IsFault()
// =========
// Return TRUE if a fault is associated with an address descriptor

boolean IsFault(AddressDescriptor addrdesc)
    return addrdesc.fault.statuscode != Fault_None;
```

Library pseudocode for shared/functions/aborts/IsSErrorInterrupt

```
// IsSErrorInterrupt()
// ===================
// Returns TRUE if the abort currently being processed is an SError interrupt, and FALSE
// otherwise.

boolean IsSErrorInterrupt(Fault statuscode)
    assert statuscode != Fault_None;

    return (statuscode IN {Fault_AsyncExternal, Fault_AsyncParity});

// IsSErrorInterrupt()
// ===================

boolean IsSErrorInterrupt(FaultRecord fault)
    return IsSErrorInterrupt(fault.statuscode);
```

Library pseudocode for shared/functions/aborts/IsSecondStage

```
// IsSecondStage()
// ===============

boolean IsSecondStage(FaultRecord fault)
    assert fault.statuscode != Fault_None;

    return fault.secondstage;
```

Library pseudocode for shared/functions/aborts/LSInstructionSyndrome

```
bits(11) LSInstructionSyndrome();
```

Library pseudocode for shared/functions/common/ASR

```
// ASR()
// =====

bits(N) ASR(bits(N) x, integer shift)
    assert shift >= 0;
    if shift == 0 then
        result = x;
    else
        (result, -) = ASR_C(x, shift);
    return result;
```

Library pseudocode for shared/functions/common/ASR_C

```
// ASR_C()
// =======

(bits(N), bit) ASR_C(bits(N) x, integer shift)
    assert shift > 0;
    shift = if shift > N then N else shift;
    extended_x = SignExtend(x, shift+N);
    result = extended_x<shift+N-1:shift>;
    carry_out = extended_x<shift-1>;
    return (result, carry_out);
```

Library pseudocode for shared/functions/common/Abs

```
// Abs()
// =====

integer Abs(integer x)
    return if x >= 0 then x else -x;

// Abs()
// =====

real Abs(real x)
    return if x >= 0.0 then x else -x;
```

Library pseudocode for shared/functions/common/Align

```
// Align()
// =======

integer Align(integer x, integer y)
    return y * (x DIV y);

// Align()
// =======

bits(N) Align(bits(N) x, integer y)
    return Align(UInt(x), y)<N-1:0>;
```

Library pseudocode for shared/functions/common/BitCount

```
// BitCount()
// ==========

integer BitCount(bits(N) x)
    integer result = 0;
    for i = 0 to N-1
        if x<i> == '1' then
            result = result + 1;
    return result;
```

Library pseudocode for shared/functions/common/CountLeadingSignBits

```
// CountLeadingSignBits()
// ======================

integer CountLeadingSignBits(bits(N) x)
    return CountLeadingZeroBits(x<N-1:1> EOR x<N-2:0>);
```

Library pseudocode for shared/functions/common/CountLeadingZeroBits

```
// CountLeadingZeroBits()
// ======================

integer CountLeadingZeroBits(bits(N) x)
    return N - (HighestSetBit(x) + 1);
```

Library pseudocode for shared/functions/common/Elem

```
// Elem[] - non-assignment form
// ============================

bits(size) Elem[bits(N) vector, integer e, integer size]
    assert e >= 0 && (e+1)*size <= N;
    return vector<e*size+size-1 : e*size>;

// Elem[] - non-assignment form
// ============================

bits(size) Elem[bits(N) vector, integer e]
    return Elem[vector, e, size];

// Elem[] - assignment form
// ========================

Elem[bits(N) &vector, integer e, integer size] = bits(size) value
    assert e >= 0 && (e+1)*size <= N;
    vector<(e+1)*size-1:e*size> = value;
    return;

// Elem[] - assignment form
// ========================

Elem[bits(N) &vector, integer e] = bits(size) value
    Elem[vector, e, size] = value;
    return;
```

Library pseudocode for shared/functions/common/Extend

```
// Extend()
// ========

bits(N) Extend(bits(M) x, integer N, boolean unsigned)
    return if unsigned then ZeroExtend(x, N) else SignExtend(x, N);

// Extend()
// ========

bits(N) Extend(bits(M) x, boolean unsigned)
    return Extend(x, N, unsigned);
```

Library pseudocode for shared/functions/common/HighestSetBit

```
// HighestSetBit()
// ===============

integer HighestSetBit(bits(N) x)
    for i = N-1 downto 0
        if x<i> == '1' then return i;
    return -1;
```

Library pseudocode for shared/functions/common/Int

```
// Int()
// =====

integer Int(bits(N) x, boolean unsigned)
    result = if unsigned then UInt(x) else SInt(x);
    return result;
```

Library pseudocode for shared/functions/common/IsOnes

```
// IsOnes()
// ========

boolean IsOnes(bits(N) x)
    return x == Ones(N);
```

Library pseudocode for shared/functions/common/IsZero

```
// IsZero()
// ========

boolean IsZero(bits(N) x)
    return x == Zeros(N);
```

Library pseudocode for shared/functions/common/IsZeroBit

```
// IsZeroBit()
// ===========

bit IsZeroBit(bits(N) x)
    return if IsZero(x) then '1' else '0';
```

Library pseudocode for shared/functions/common/LSL

```
// LSL()
// =====

bits(N) LSL(bits(N) x, integer shift)
    assert shift >= 0;
    if shift == 0 then
        result = x;
    else
        (result, -) = LSL_C(x, shift);
    return result;
```

Library pseudocode for shared/functions/common/LSL_C

```
// LSL_C()
// =======

(bits(N), bit) LSL_C(bits(N) x, integer shift)
    assert shift > 0;
    shift = if shift > N then N else shift;
    extended_x = x : Zeros(shift);
    result = extended_x<N-1:0>;
    carry_out = extended_x<N>;
    return (result, carry_out);
```

Library pseudocode for shared/functions/common/LSR

```
// LSR()
// =====

bits(N) LSR(bits(N) x, integer shift)
    assert shift >= 0;
    if shift == 0 then
        result = x;
    else
        (result, -) = LSR_C(x, shift);
    return result;
```

Library pseudocode for shared/functions/common/LSR_C

```
// LSR_C()
// =======

(bits(N), bit) LSR_C(bits(N) x, integer shift)
    assert shift > 0;
    shift = if shift > N then N else shift;
    extended_x = ZeroExtend(x, shift+N);
    result = extended_x<shift+N-1:shift>;
    carry_out = extended_x<shift-1>;
    return (result, carry_out);
```

Library pseudocode for shared/functions/common/LowestSetBit

```
// LowestSetBit()
// ==============

integer LowestSetBit(bits(N) x)
    for i = 0 to N-1
        if x<i> == '1' then return i;
    return N;
```

Library pseudocode for shared/functions/common/Max

```
// Max()
// =====

integer Max(integer a, integer b)
    return if a >= b then a else b;

// Max()
// =====

real Max(real a, real b)
    return if a >= b then a else b;
```

Library pseudocode for shared/functions/common/Min

```
// Min()
// =====

integer Min(integer a, integer b)
    return if a <= b then a else b;

// Min()
// =====

real Min(real a, real b)
    return if a <= b then a else b;
```

Library pseudocode for shared/functions/common/Ones

```
// Ones()
// ======

bits(N) Ones(integer N)
    return Replicate('1',N);

// Ones()
// ======

bits(N) Ones()
    return Ones(N);
```

Library pseudocode for shared/functions/common/ROR

```
// ROR()
// =====

bits(N) ROR(bits(N) x, integer shift)
    assert shift >= 0;
    if shift == 0 then
        result = x;
    else
        (result, -) = ROR_C(x, shift);
    return result;
```

Library pseudocode for shared/functions/common/ROR_C

```
// ROR_C()
// =======

(bits(N), bit) ROR_C(bits(N) x, integer shift)
    assert shift != 0;
    m = shift MOD N;
    result = LSR(x,m) OR LSL(x,N-m);
    carry_out = result<N-1>;
    return (result, carry_out);
```

Library pseudocode for shared/functions/common/Replicate

```
// Replicate()
// ===========

bits(N) Replicate(bits(M) x)
    assert N MOD M == 0;
    return Replicate(x, N DIV M);

bits(M*N) Replicate(bits(M) x, integer N);
```

Library pseudocode for shared/functions/common/RoundDown

```
integer RoundDown(real x);
```

Library pseudocode for shared/functions/common/RoundTowardsZero

```
// RoundTowardsZero()
// ==================

integer RoundTowardsZero(real x)
    return if x == 0.0 then 0 else if x >= 0.0 then RoundDown(x) else RoundUp(x);
```

Library pseudocode for shared/functions/common/RoundUp

```
integer RoundUp(real x);
```

Library pseudocode for shared/functions/common/SInt

```
// SInt()
// ======

integer SInt(bits(N) x)
    result = 0;
    for i = 0 to N-1
        if x<i> == '1' then result = result + 2^i;
    if x<N-1> == '1' then result = result - 2^N;
    return result;
```

Library pseudocode for shared/functions/common/SignExtend

```
// SignExtend()
// ============

bits(N) SignExtend(bits(M) x, integer N)
    assert N >= M;
    return Replicate(x<M-1>, N-M) : x;

// SignExtend()
// ============

bits(N) SignExtend(bits(M) x)
    return SignExtend(x, N);
```

Library pseudocode for shared/functions/common/UInt

```
// UInt()
// ======

integer UInt(bits(N) x)
    result = 0;
    for i = 0 to N-1
        if x<i> == '1' then result = result + 2^i;
    return result;
```

Library pseudocode for shared/functions/common/ZeroExtend

```
// ZeroExtend()
// ============

bits(N) ZeroExtend(bits(M) x, integer N)
    assert N >= M;
    return Zeros(N-M) : x;

// ZeroExtend()
// ============

bits(N) ZeroExtend(bits(M) x)
    return ZeroExtend(x, N);
```

Library pseudocode for shared/functions/common/Zeros

```
// Zeros()
// =======

bits(N) Zeros(integer N)
    return Replicate('0',N);

// Zeros()
// =======

bits(N) Zeros()
    return Zeros(N);
```

Library pseudocode for shared/functions/crc/BitReverse

```
// BitReverse()
// ============

bits(N) BitReverse(bits(N) data)
    bits(N) result;
    for i = 0 to N-1
        result<N-i-1> = data<i>;
    return result;
```

Library pseudocode for shared/functions/crc/HaveCRCExt

```
// HaveCRCExt()
// ============

boolean HaveCRCExt()
    return HasArchVersion(ARMv8p1) || boolean IMPLEMENTATION_DEFINED "Have CRC extension";
```

Library pseudocode for shared/functions/crc/Poly32Mod2

```
// Poly32Mod2()
// ============

// Poly32Mod2 on a bitstring does a polynomial Modulus over {0,1} operation

bits(32) Poly32Mod2(bits(N) data, bits(32) poly)
    assert N > 32;
    for i = N-1 downto 32
        if data<i> == '1' then
            data<i-1:0> = data<i-1:0> EOR (poly:Zeros(i-32));
    return data<31:0>;
```

Library pseudocode for shared/functions/crypto/AESInvMixColumns

```
bits(128) AESInvMixColumns(bits (128) op);
```

Library pseudocode for shared/functions/crypto/AESInvShiftRows

```
bits(128) AESInvShiftRows(bits(128) op);
```

Library pseudocode for shared/functions/crypto/AESInvSubBytes

```
bits(128) AESInvSubBytes(bits(128) op);
```

Library pseudocode for shared/functions/crypto/AESMixColumns

```
bits(128) AESMixColumns(bits (128) op);
```

Library pseudocode for shared/functions/crypto/AESShiftRows

```
bits(128) AESShiftRows(bits(128) op);
```

Library pseudocode for shared/functions/crypto/AESSubBytes

```
bits(128) AESSubBytes(bits(128) op);
```

Library pseudocode for shared/functions/crypto/HaveAESExt

```
// HaveAESExt()
// ============
// TRUE if AES cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveAESExt()
    return boolean IMPLEMENTATION_DEFINED "Has AES Crypto instructions";
```

Library pseudocode for shared/functions/crypto/HaveBit128PMULLExt

```
// HaveBit128PMULLExt()
// ====================
// TRUE if 128 bit form of PMULL instructions support is implemented,
// FALSE otherwise.

boolean HaveBit128PMULLExt()
    return boolean IMPLEMENTATION_DEFINED "Has 128-bit form of PMULL instructions";
```

Library pseudocode for shared/functions/crypto/HaveSHA1Ext

```
// HaveSHA1Ext()
// =============
// TRUE if SHA1 cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveSHA1Ext()
    return boolean IMPLEMENTATION_DEFINED "Has SHA1 Crypto instructions";
```

Library pseudocode for shared/functions/crypto/HaveSHA256Ext

```
// HaveSHA256Ext()
// ===============
// TRUE if SHA256 cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveSHA256Ext()
    return boolean IMPLEMENTATION_DEFINED "Has SHA256 Crypto instructions";
```

Library pseudocode for shared/functions/crypto/HaveSHA3Ext

```
// HaveSHA3Ext()
// =============
// TRUE if SHA3 cryptographic instructions support is implemented,
// and when SHA1 and SHA2 basic cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveSHA3Ext()
    if !HasArchVersion(ARMv8p2) || !(HaveSHA1Ext() && HaveSHA256Ext()) then
        return FALSE;
    return boolean IMPLEMENTATION_DEFINED "Has SHA3 Crypto instructions";
```

Library pseudocode for shared/functions/crypto/HaveSHA512Ext

```
// HaveSHA512Ext()
// ===============
// TRUE if SHA512 cryptographic instructions support is implemented,
// and when SHA1 and SHA2 basic cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveSHA512Ext()
    if !HasArchVersion(ARMv8p2) || !(HaveSHA1Ext() && HaveSHA256Ext()) then
        return FALSE;
    return boolean IMPLEMENTATION_DEFINED "Has SHA512 Crypto instructions";
```

Library pseudocode for shared/functions/crypto/HaveSM3Ext

```
// HaveSM3Ext()
// ============
// TRUE if SM3 cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveSM3Ext()
    if !HasArchVersion(ARMv8p2) then
        return FALSE;
    return boolean IMPLEMENTATION_DEFINED "Has SM3 Crypto instructions";
```

Library pseudocode for shared/functions/crypto/HaveSM4Ext

```
// HaveSM4Ext()
// ============
// TRUE if SM4 cryptographic instructions support is implemented,
// FALSE otherwise.

boolean HaveSM4Ext()
    if !HasArchVersion(ARMv8p2) then
        return FALSE;
    return boolean IMPLEMENTATION_DEFINED "Has SM4 Crypto instructions";
```

Library pseudocode for shared/functions/crypto/ROL

```
// ROL()
// =====

bits(N) ROL(bits(N) x, integer shift)
    assert shift >= 0 && shift <= N;
    if (shift == 0) then
        return x;
    return ROR(x, N-shift);
```

Library pseudocode for shared/functions/crypto/SHA256hash

```
// SHA256hash()
// ============

bits(128) SHA256hash(bits (128) X, bits(128) Y, bits(128) W, boolean part1)
    bits(32) chs, maj, t;

    for e = 0 to 3
        chs = SHAchoose(Y<31:0>, Y<63:32>, Y<95:64>);
        maj = SHAmajority(X<31:0>, X<63:32>, X<95:64>);
        t = Y<127:96> + SHAhashSIGMA1(Y<31:0>) + chs + Elem[W, e, 32];
        X<127:96> = t + X<127:96>;
        Y<127:96> = t + SHAhashSIGMA0(X<31:0>) + maj;
        <Y, X> = ROL(Y : X, 32);
    return (if part1 then X else Y);
```

Library pseudocode for shared/functions/crypto/SHAchoose

```
// SHAchoose()
// ===========

bits(32) SHAchoose(bits(32) x, bits(32) y, bits(32) z)
    return (((y EOR z) AND x) EOR z);
```

Library pseudocode for shared/functions/crypto/SHAhashSIGMA0

```
// SHAhashSIGMA0()
// ===============

bits(32) SHAhashSIGMA0(bits(32) x)
    return ROR(x, 2) EOR ROR(x, 13) EOR ROR(x, 22);
```

Library pseudocode for shared/functions/crypto/SHAhashSIGMA1

```
// SHAhashSIGMA1()
// ===============

bits(32) SHAhashSIGMA1(bits(32) x)
    return ROR(x, 6) EOR ROR(x, 11) EOR ROR(x, 25);
```

Library pseudocode for shared/functions/crypto/SHAmajority

```
// SHAmajority()
// =============

bits(32) SHAmajority(bits(32) x, bits(32) y, bits(32) z)
    return ((x AND y) OR ((x OR y) AND z));
```

Library pseudocode for shared/functions/crypto/SHAparity

```
// SHAparity()
// ===========

bits(32) SHAparity(bits(32) x, bits(32) y, bits(32) z)
    return (x EOR y EOR z);
```

Library pseudocode for shared/functions/crypto/Sbox

```
// Sbox()
// ======
// Used in SM4E crypto instruction

bits(8) Sbox(bits(8) sboxin)
    bits(8) sboxout;
    bits(2048) sboxstring = 0xd690e9fecce13db716b614c228fb2c052b679a762abe04c3aa441326498606999c4250f491e

    sboxout = sboxstring<(255-UInt(sboxin))*8+7:(255-UInt(sboxin))*8>;
    return sboxout;
```

Library pseudocode for shared/functions/exclusive/ClearExclusiveByAddress

```
// Clear the global Exclusives monitors for all PEs EXCEPT processorid if they
// record any part of the physical address region of size bytes starting at paddress.
// It is IMPLEMENTATION DEFINED whether the global Exclusives monitor for processorid
// is also cleared if it records any part of the address region.
ClearExclusiveByAddress(FullAddress paddress, integer processorid, integer size);
```

Library pseudocode for shared/functions/exclusive/ClearExclusiveLocal

```
// Clear the local Exclusives monitor for the specified processorid.
ClearExclusiveLocal(integer processorid);
```

Library pseudocode for shared/functions/exclusive/ClearExclusiveMonitors

```
// ClearExclusiveMonitors()
// ========================

// Clear the local Exclusives monitor for the executing PE.

ClearExclusiveMonitors()
    ClearExclusiveLocal(ProcessorID());
```

Library pseudocode for shared/functions/exclusive/ExclusiveMonitorsStatus

```
// Returns '0' to indicate success if the last memory write by this PE was to
// the same physical address region endorsed by ExclusiveMonitorsPass().
// Returns '1' to indicate failure if address translation resulted in a different
// physical address.
bit ExclusiveMonitorsStatus();
```

Library pseudocode for shared/functions/exclusive/IsExclusiveGlobal

```
// Return TRUE if the global Exclusives monitor for processorid includes all of
// the physical address region of size bytes starting at paddress.
boolean IsExclusiveGlobal(FullAddress paddress, integer processorid, integer size);
```

Library pseudocode for shared/functions/exclusive/IsExclusiveLocal

```
// Return TRUE if the local Exclusives monitor for processorid includes all of
// the physical address region of size bytes starting at paddress.
boolean IsExclusiveLocal(FullAddress paddress, integer processorid, integer size);
```

Library pseudocode for shared/functions/exclusive/MarkExclusiveGlobal

```
// Record the physical address region of size bytes starting at paddress in
// the global Exclusives monitor for processorid.
MarkExclusiveGlobal(FullAddress paddress, integer processorid, integer size);
```

Library pseudocode for shared/functions/exclusive/MarkExclusiveLocal

```
// Record the physical address region of size bytes starting at paddress in
// the local Exclusives monitor for processorid.
MarkExclusiveLocal(FullAddress paddress, integer processorid, integer size);
```

Library pseudocode for shared/functions/exclusive/ProcessorID

```
// Return the ID of the currently executing PE.
integer ProcessorID();
```

Library pseudocode for shared/functions/extension/AArch32.HaveHPDExt

```
// AArch32.HaveHPDExt()
// ====================

boolean AArch32.HaveHPDExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/AArch64.HaveHPDExt

```
// AArch64.HaveHPDExt()
// ====================

boolean AArch64.HaveHPDExt()
    return HasArchVersion(ARMv8p1);
```

Library pseudocode for shared/functions/extension/Have52BitPAExt

```
// Have52BitPAExt()
// ================

boolean Have52BitPAExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/Have52BitVAExt

```
// Have52BitVAExt()
// ================

boolean Have52BitVAExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveAtomicExt

```
// HaveAtomicExt()
// ===============

boolean HaveAtomicExt()
    return HasArchVersion(ARMv8p1);
```

Library pseudocode for shared/functions/extension/HaveBTIExt

```
// HaveBTIExt()
// ============
// Returns TRUE if support for Branch Target Indentification is implemented.

boolean HaveBTIExt()
    return HasArchVersion(ARMv8p5);
```

Library pseudocode for shared/functions/extension/HaveBlockBBM

```
// HaveBlockBBM()
// ==============
// Returns TRUE if support for changing block size without requring break-before-make is implemented.

boolean HaveBlockBBM()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveCommonNotPrivateTransExt

```
// HaveCommonNotPrivateTransExt()
// ==============================

boolean HaveCommonNotPrivateTransExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveDITExt

```
// HaveDITExt()
// ============

boolean HaveDITExt()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveDOTPExt

```
// HaveDOTPExt()
// =============
// Returns TRUE if Dot Product feature support is implemented, and FALSE otherwise.

boolean HaveDOTPExt()
    return HasArchVersion(ARMv8p4) || (HasArchVersion(ARMv8p2) && boolean IMPLEMENTATION_DEFINED "Has Dot
```

Library pseudocode for shared/functions/extension/HaveDoPD

```
// HaveDoPD()
// ==========
// Returns TRUE if Debug Over Power Down extension
// support is implemented and FALSE otherwise.

boolean HaveDoPD()
    return HasArchVersion(ARMv8p2) && boolean IMPLEMENTATION_DEFINED "Has DoPD extension";
```

Library pseudocode for shared/functions/extension/HaveDoubleFaultExt

```
// HaveDoubleFaultExt()
// ====================

boolean HaveDoubleFaultExt()
    return (HasArchVersion(ARMv8p4) && HaveEL(EL3) && !ELUsingAArch32(EL3) && HaveIESB());
```

Library pseudocode for shared/functions/extension/HaveDoubleLock

```
// HaveDoubleLock()
// ================
// Returns TRUE if support for the OS Double Lock is implemented.

boolean HaveDoubleLock()
    return !HasArchVersion(ARMv8p4) || boolean IMPLEMENTATION_DEFINED "OS Double Lock is implemented";
```

Library pseudocode for shared/functions/extension/HaveE0PDExt

```
// HaveE0PDExt()
// =============
// Returns TRUE if support for constant fault times for unprivileged accesses
// to the memory map is implemented.

boolean HaveE0PDExt()
    return HasArchVersion(ARMv8p5);
```

Library pseudocode for shared/functions/extension/HaveExtendedCacheSets

```
// HaveExtendedCacheSets()
// =======================

boolean HaveExtendedCacheSets()
    return HasArchVersion(ARMv8p3);
```

Library pseudocode for shared/functions/extension/HaveExtendedECDebugEvents

```
// HaveExtendedECDebugEvents()
// ===========================

boolean HaveExtendedECDebugEvents()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveExtendedExecuteNeverExt

```
// HaveExtendedExecuteNeverExt()
// =============================

boolean HaveExtendedExecuteNeverExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveFCADDExt

```
// HaveFCADDExt()
// ==============

boolean HaveFCADDExt()
    return HasArchVersion(ARMv8p3);
```

Library pseudocode for shared/functions/extension/HaveFJCVTZSExt

```
// HaveFJCVTZSExt()
// ================

boolean HaveFJCVTZSExt()
    return HasArchVersion(ARMv8p3);
```

Library pseudocode for shared/functions/extension/HaveFP16MulNoRoundingToFP32Ext

```
// HaveFP16MulNoRoundingToFP32Ext()
// ================================
// Returns TRUE if has FP16 multiply with no intermediate rounding accumulate to FP32 instructions,
// and FALSE otherwise

boolean HaveFP16MulNoRoundingToFP32Ext()
    if !HaveFP16Ext() then return FALSE;
    if HasArchVersion(ARMv8p4) then return TRUE;
    return (HasArchVersion(ARMv8p2) &&
            boolean IMPLEMENTATION_DEFINED "Has accumulate FP16 product into FP32 extension");
```

Library pseudocode for shared/functions/extension/HaveFlagFormatExt

```
// HaveFlagFormatExt()
// ===================
// Returns TRUE if flag format conversion instructions implemented.

boolean HaveFlagFormatExt()
    return HasArchVersion(ARMv8p5);
```

Library pseudocode for shared/functions/extension/HaveFlagManipulateExt

```
// HaveFlagManipulateExt()
// =======================
// Returns TRUE if flag manipulate instructions are implemented.

boolean HaveFlagManipulateExt()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveFrintExt

```
// HaveFrintExt()
// ==============
// Returns TRUE if FRINT instructions are implemented.

boolean HaveFrintExt()
    return HasArchVersion(ARMv8p5);
```

Library pseudocode for shared/functions/extension/HaveHPMDExt

```
// HaveHPMDExt()
// =============

boolean HaveHPMDExt()
    return HasArchVersion(ARMv8p1);
```

Library pseudocode for shared/functions/extension/HaveIDSExt

```
// HaveIDSExt()
// ============
// Returns TRUE if ID register handling feature is implemented.

boolean HaveIDSExt()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveIESB

```
// HaveIESB()
// ==========

boolean HaveIESB()
    return (HaveRASExt() &&
            boolean IMPLEMENTATION_DEFINED "Has Implicit Error Synchronization Barrier");
```

Library pseudocode for shared/functions/extension/HaveMPAMExt

```
// HaveMPAMExt()
// =============
// Returns TRUE if MPAM is implemented, and FALSE otherwise.

boolean HaveMPAMExt()
    return (HasArchVersion(ARMv8p2) &&
            boolean IMPLEMENTATION_DEFINED "Has MPAM extension");
```

Library pseudocode for shared/functions/extension/HaveMTEExt

```
// HaveMTEExt()
// ============
// Returns TRUE if MTE implemented, and FALSE otherwise.

boolean HaveMTEExt()
    if !HasArchVersion(ARMv8p5) then
        return FALSE;
    return boolean IMPLEMENTATION_DEFINED "Has MTE extension";
```

Library pseudocode for shared/functions/extension/HaveNV2Ext

```
// HaveNV2Ext()
// ============
// Returns TRUE if Enhanced Nested Virtualization is implemented.

boolean HaveNV2Ext()
    return (HasArchVersion(ARMv8p4) && HaveNVExt()
            && boolean IMPLEMENTATION_DEFINED "Has support for Enhanced Nested Virtualization");
```

Library pseudocode for shared/functions/extension/HaveNVExt

```
// HaveNVExt()
// ===========
// Returns TRUE if Nested Virtualization is implemented.

boolean HaveNVExt()
    return HasArchVersion(ARMv8p3) && boolean IMPLEMENTATION_DEFINED "Has Nested Virtualization";
```

Library pseudocode for shared/functions/extension/HaveNoSecurePMUDisableOverride

```
// HaveNoSecurePMUDisableOverride()
// ================================

boolean HaveNoSecurePMUDisableOverride()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveNoninvasiveDebugAuth

```
// HaveNoninvasiveDebugAuth()
// ==========================
// Returns TRUE if the Non-invasive debug controls are implemented.

boolean HaveNoninvasiveDebugAuth()
    return !HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HavePANExt

```
// HavePANExt()
// ============

boolean HavePANExt()
    return HasArchVersion(ARMv8p1);
```

Library pseudocode for shared/functions/extension/HavePageBasedHardwareAttributes

```
// HavePageBasedHardwareAttributes()
// =================================

boolean HavePageBasedHardwareAttributes()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HavePrivATExt

```
// HavePrivATExt()
// ===============

boolean HavePrivATExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveQRDMLAHExt

```
// HaveQRDMLAHExt()
// ================

boolean HaveQRDMLAHExt()
    return HasArchVersion(ARMv8p1);

boolean HaveAccessFlagUpdateExt()
    return HasArchVersion(ARMv8p1);

boolean HaveDirtyBitModifierExt()
    return HasArchVersion(ARMv8p1);
```

Library pseudocode for shared/functions/extension/HaveRASExt

```
// HaveRASExt()
// ============

boolean HaveRASExt()
    return (HasArchVersion(ARMv8p2) ||
            boolean IMPLEMENTATION_DEFINED "Has RAS extension");
```

Library pseudocode for shared/functions/extension/HaveSBExt

```
// HaveSBExt()
// ===========
// Returns TRUE if support for SB is implemented, and FALSE otherwise.

boolean HaveSBExt()
    return HasArchVersion(ARMv8p5) || boolean IMPLEMENTATION_DEFINED "Has SB extension";
```

Library pseudocode for shared/functions/extension/HaveSSBSExt

```
// HaveSSBSExt()
// =============
// Returns TRUE if support for SSBS is implemented, and FALSE otherwise.

boolean HaveSSBSExt()
    return HasArchVersion(ARMv8p5) || boolean IMPLEMENTATION_DEFINED "Has SSBS extension";
```

Library pseudocode for shared/functions/extension/HaveSecureEL2Ext

```
// HaveSecureEL2Ext()
// ==================
// Returns TRUE if Secure EL2 is implemented.

boolean HaveSecureEL2Ext()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveSecureExtDebugView

```
// HaveSecureExtDebugView()
// ========================
// Returns TRUE if support for Secure and Non-secure views of debug peripherals is implemented.

boolean HaveSecureExtDebugView()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveSelfHostedTrace

```
// HaveSelfHostedTrace()
// =====================

boolean HaveSelfHostedTrace()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveSmallPageTblExt

```
// HaveSmallPageTblExt()
// =====================
// Returns TRUE if Small Page Table Support is implemented.

boolean HaveSmallPageTblExt()
    return HasArchVersion(ARMv8p4) && boolean IMPLEMENTATION_DEFINED "Has Small Page Table extension";
```

Library pseudocode for shared/functions/extension/HaveStage2MemAttrControl

```
// HaveStage2MemAttrControl()
// ==========================
// Returns TRUE if support for Stage2 control of memory types and cacheability attributes is implemented.

boolean HaveStage2MemAttrControl()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveStatisticalProfiling

```
// HaveStatisticalProfiling()
// ==========================

boolean HaveStatisticalProfiling()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveTME

```
// HaveTME()
// =========

boolean HaveTME()
    return boolean IMPLEMENTATION_DEFINED "Has Transactional Memory extension";
```

Library pseudocode for shared/functions/extension/HaveTraceBufferExtension

```
// HaveTraceBufferExtension()
// ==========================
// Returns TRUE if support for the Trace Buffer Extension is implemented. This feature depends upon
// the Secure External Debug view feature being implemented. Returns FALSE otherwise.

boolean HaveTraceBufferExtension()
    return HaveSecureExtDebugView() && boolean IMPLEMENTATION_DEFINED "Trace Buffer Extension implemented
```

Library pseudocode for shared/functions/extension/HaveTraceExt

```
// HaveTraceExt()
// ==============
// Returns TRUE if Trace functionality as described by the Trace Architecture
// is implemented.

boolean HaveTraceExt()
    return boolean IMPLEMENTATION_DEFINED "Has Trace Architecture functionality";
```

Library pseudocode for shared/functions/extension/HaveTrapLoadStoreMultipleDeviceExt

```
// HaveTrapLoadStoreMultipleDeviceExt()
// ====================================

boolean HaveTrapLoadStoreMultipleDeviceExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveUA16Ext

```
// HaveUA16Ext()
// =============
// Returns TRUE if extended unaligned memory access support is implemented, and FALSE otherwise.

boolean HaveUA16Ext()
    return HasArchVersion(ARMv8p4);
```

Library pseudocode for shared/functions/extension/HaveUAOExt

```
// HaveUAOExt()
// ============

boolean HaveUAOExt()
    return HasArchVersion(ARMv8p2);
```

Library pseudocode for shared/functions/extension/HaveVirtHostExt

```
// HaveVirtHostExt()
// =================

boolean HaveVirtHostExt()
    return HasArchVersion(ARMv8p1);
```

Library pseudocode for shared/functions/extension/InsertIESBBeforeException

```
// If SCTLR_ELx.IESB is 1 when an exception is generated to ELx, any pending Unrecoverable
// SError interrupt must be taken before executing any instructions in the exception handler.
// However, this can be before the branch to the exception handler is made.
boolean InsertIESBBeforeException(bits(2) el);
```

Library pseudocode for shared/functions/float/fixedtofp/FixedToFP

```
// FixedToFP()
// ===========

// Convert M-bit fixed point OP with FBITS fractional bits to
// N-bit precision floating point, controlled by UNSIGNED and ROUNDING.

bits(N) FixedToFP(bits(M) op, integer fbits, boolean unsigned, FPCRType fpcr, FPRounding rounding)
    assert N IN {16,32,64};
    assert M IN {16,32,64};
    bits(N) result;
    assert fbits >= 0;
    assert rounding != FPRounding_ODD;

    // Correct signed-ness
    int_operand = Int(op, unsigned);

    // Scale by fractional bits and generate a real value
    real_operand = Real(int_operand) / 2.0^fbits;

    if real_operand == 0.0 then
        result = FPZero('0');
    else
        result = FPRound(real_operand, fpcr, rounding);

    return result;
```

Library pseudocode for shared/functions/float/fpabs/FPAbs

```
// FPAbs()
// =======

bits(N) FPAbs(bits(N) op)
    assert N IN {16,32,64};
    return '0' : op<N-2:0>;
```

Library pseudocode for shared/functions/float/fpadd/FPAdd

```
// FPAdd()
// =======

bits(N) FPAdd(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    rounding = FPRoundingMode(fpcr);
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);  inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);     zero2 = (type2 == FPType_Zero);
        if inf1 && inf2 && sign1 == NOT(sign2) then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);
        elsif (inf1 && sign1 == '0') || (inf2 && sign2 == '0') then
            result = FPInfinity('0');
        elsif (inf1 && sign1 == '1') || (inf2 && sign2 == '1') then
            result = FPInfinity('1');
        elsif zero1 && zero2 && sign1 == sign2 then
            result = FPZero(sign1);
        else
            result_value = value1 + value2;
            if result_value == 0.0 then  // Sign of exact zero result depends on rounding mode
                result_sign = if rounding == FPRounding_NEGINF then '1' else '0';
                result = FPZero(result_sign);
            else
                result = FPRound(result_value, fpcr, rounding);
    return result;
```

Library pseudocode for shared/functions/float/fpcompare/FPCompare

```
// FPCompare()
// ===========

bits(4) FPCompare(bits(N) op1, bits(N) op2, boolean signal_nans, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    if type1==FPType_SNaN || type1==FPType_QNaN || type2==FPType_SNaN || type2==FPType_QNaN then
        result = '0011';
        if type1==FPType_SNaN || type2==FPType_SNaN || signal_nans then
            FPProcessException(FPExc_InvalidOp, fpcr);
    else
        // All non-NaN cases can be evaluated on the values produced by FPUnpack()
        if value1 == value2 then
            result = '0110';
        elsif value1 < value2 then
            result = '1000';
        else  // value1 > value2
            result = '0010';
    return result;
```

Library pseudocode for shared/functions/float/fpcompareeq/FPCompareEQ

```
// FPCompareEQ()
// =============

boolean FPCompareEQ(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    if type1==FPType_SNaN || type1==FPType_QNaN || type2==FPType_SNaN || type2==FPType_QNaN then
        result = FALSE;
        if type1==FPType_SNaN || type2==FPType_SNaN then
            FPProcessException(FPExc_InvalidOp, fpcr);
    else
        // All non-NaN cases can be evaluated on the values produced by FPUnpack()
        result = (value1 == value2);
    return result;
```

Library pseudocode for shared/functions/float/fpcomparege/FPCompareGE

```
// FPCompareGE()
// =============

boolean FPCompareGE(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    if type1==FPType_SNaN || type1==FPType_QNaN || type2==FPType_SNaN || type2==FPType_QNaN then
        result = FALSE;
        FPProcessException(FPExc_InvalidOp, fpcr);
    else
        // All non-NaN cases can be evaluated on the values produced by FPUnpack()
        result = (value1 >= value2);
    return result;
```

Library pseudocode for shared/functions/float/fpcomparegt/FPCompareGT

```
// FPCompareGT()
// =============

boolean FPCompareGT(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    if type1==FPType_SNaN || type1==FPType_QNaN || type2==FPType_SNaN || type2==FPType_QNaN then
        result = FALSE;
        FPProcessException(FPExc_InvalidOp, fpcr);
    else
        // All non-NaN cases can be evaluated on the values produced by FPUnpack()
        result = (value1 > value2);
    return result;
```

Library pseudocode for shared/functions/float/fpconvert/FPConvert

```
// FPConvert()
// ===========

// Convert floating point OP with N-bit precision to M-bit precision,
// with rounding controlled by ROUNDING.
// This is used by the FP-to-FP conversion instructions and so for
// half-precision data ignores FZ16, but observes AHP.

bits(M) FPConvert(bits(N) op, FPCRType fpcr, FPRounding rounding)
    assert M IN {16,32,64};
    assert N IN {16,32,64};
    bits(M) result;

    // Unpack floating-point operand optionally with flush-to-zero.
    (fptype,sign,value) = FPUnpackCV(op, fpcr);

    alt_hp = (M == 16) && (fpcr.AHP == '1');

    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        if alt_hp then
            result = FPZero(sign);
        elsif fpcr.DN == '1' then
            result = FPDefaultNaN();
        else
            result = FPConvertNaN(op);
        if fptype == FPType_SNaN || alt_hp then
            FPProcessException(FPExc_InvalidOp,fpcr);
    elsif fptype == FPType_Infinity then
        if alt_hp then
            result = sign:Ones(M-1);
            FPProcessException(FPExc_InvalidOp, fpcr);
        else
            result = FPInfinity(sign);
    elsif fptype == FPType_Zero then
        result = FPZero(sign);
    else
        result = FPRoundCV(value, fpcr, rounding);
    return result;

// FPConvert()
// ===========

bits(M) FPConvert(bits(N) op, FPCRType fpcr)
    return FPConvert(op, fpcr, FPRoundingMode(fpcr));
```

Library pseudocode for shared/functions/float/fpconvertnan/FPConvertNaN

```
// FPConvertNaN()
// ==============
// Converts a NaN of one floating-point type to another

bits(M) FPConvertNaN(bits(N) op)
    assert N IN {16,32,64};
    assert M IN {16,32,64};
    bits(M) result;
    bits(51) frac;

    sign = op<N-1>;

    // Unpack payload from input NaN
    case N of
        when 64 frac = op<50:0>;
        when 32 frac = op<21:0>:Zeros(29);
        when 16 frac = op<8:0>:Zeros(42);

    // Repack payload into output NaN, while
    // converting an SNaN to a QNaN.
    case M of
        when 64 result = sign:Ones(M-52):frac;
        when 32 result = sign:Ones(M-23):frac<50:29>;
        when 16 result = sign:Ones(M-10):frac<50:42>;

    return result;
```

Library pseudocode for shared/functions/float/fpcrtype/FPCRType

```
type FPCRType;
```

Library pseudocode for shared/functions/float/fpdecoderm/FPDecodeRM

```
// FPDecodeRM()
// ============

// Decode most common AArch32 floating-point rounding encoding.

FPRounding FPDecodeRM(bits(2) rm)
    case rm of
        when '00' return FPRounding_TIEAWAY; // A
        when '01' return FPRounding_TIEEVEN; // N
        when '10' return FPRounding_POSINF;  // P
        when '11' return FPRounding_NEGINF;  // M
```

Library pseudocode for shared/functions/float/fpdecoderounding/FPDecodeRounding

```
// FPDecodeRounding()
// ==================

// Decode floating-point rounding mode and common AArch64 encoding.

FPRounding FPDecodeRounding(bits(2) rmode)
    case rmode of
        when '00' return FPRounding_TIEEVEN; // N
        when '01' return FPRounding_POSINF;  // P
        when '10' return FPRounding_NEGINF;  // M
        when '11' return FPRounding_ZERO;    // Z
```

Library pseudocode for shared/functions/float/fpdefaultnan/FPDefaultNaN

```
// FPDefaultNaN()
// ==============

bits(N) FPDefaultNaN()
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    sign = '0';
    exp  = Ones(E);
    frac = '1':Zeros(F-1);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/fpdiv/FPDiv

```
// FPDiv()
// =======

bits(N) FPDiv(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);
        inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);
        zero2 = (type2 == FPType_Zero);
        if (inf1 && inf2) || (zero1 && zero2) then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);
        elsif inf1 || zero2 then
            result = FPInfinity(sign1 EOR sign2);
            if !inf1 then FPProcessException(FPExc_DivideByZero, fpcr);
        elsif zero1 || inf2 then
            result = FPZero(sign1 EOR sign2);
        else
            result = FPRound(value1/value2, fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpexc/FPExc

```
enumeration FPExc       {FPExc_InvalidOp, FPExc_DivideByZero, FPExc_Overflow,
                         FPExc_Underflow, FPExc_Inexact, FPExc_InputDenorm};
```

Library pseudocode for shared/functions/float/fpinfinity/FPInfinity

```
// FPInfinity()
// ============

bits(N) FPInfinity(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp  = Ones(E);
    frac = Zeros(F);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/fpmax/FPMax

```
// FPMax()
// =======

bits(N) FPMax(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        if value1 > value2 then
            (fptype,sign,value) = (type1,sign1,value1);
        else
            (fptype,sign,value) = (type2,sign2,value2);
        if fptype == FPType_Infinity then
            result = FPInfinity(sign);
        elsif fptype == FPType_Zero then
            sign = sign1 AND sign2; // Use most positive sign
            result = FPZero(sign);
        else
            // The use of FPRound() covers the case where there is a trapped underflow exception
            // for a denormalized number even though the result is exact.
            result = FPRound(value, fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpmaxnormal/FPMaxNormal

```
// FPMaxNormal()
// =============

bits(N) FPMaxNormal(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp  = Ones(E-1):'0';
    frac = Ones(F);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/fpmaxnum/FPMaxNum

```
// FPMaxNum()
// ==========

bits(N) FPMaxNum(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,-,-) = FPUnpack(op1, fpcr);
    (type2,-,-) = FPUnpack(op2, fpcr);

    // treat a single quiet-NaN as -Infinity
    if type1 == FPType_QNaN && type2 != FPType_QNaN then
        op1 = FPInfinity('1');
    elsif type1 != FPType_QNaN && type2 == FPType_QNaN then
        op2 = FPInfinity('1');

    return FPMax(op1, op2, fpcr);
```

Library pseudocode for shared/functions/float/fpmin/FPMin

```
// FPMin()
// =======

bits(N) FPMin(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        if value1 < value2 then
            (fptype,sign,value) = (type1,sign1,value1);
        else
            (fptype,sign,value) = (type2,sign2,value2);
        if fptype == FPType_Infinity then
            result = FPInfinity(sign);
        elsif fptype == FPType_Zero then
            sign = sign1 OR sign2; // Use most negative sign
            result = FPZero(sign);
        else
            // The use of FPRound() covers the case where there is a trapped underflow exception
            // for a denormalized number even though the result is exact.
            result = FPRound(value, fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpminnum/FPMinNum

```
// FPMinNum()
// ==========

bits(N) FPMinNum(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,-,-) = FPUnpack(op1, fpcr);
    (type2,-,-) = FPUnpack(op2, fpcr);

    // Treat a single quiet-NaN as +Infinity
    if type1 == FPType_QNaN && type2 != FPType_QNaN then
        op1 = FPInfinity('0');
    elsif type1 != FPType_QNaN && type2 == FPType_QNaN then
        op2 = FPInfinity('0');

    return FPMin(op1, op2, fpcr);
```

Library pseudocode for shared/functions/float/fpmul/FPMul

```
// FPMul()
// =======

bits(N) FPMul(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);
        inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);
        zero2 = (type2 == FPType_Zero);
        if (inf1 && zero2) || (zero1 && inf2) then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);
        elsif inf1 || inf2 then
            result = FPInfinity(sign1 EOR sign2);
        elsif zero1 || zero2 then
            result = FPZero(sign1 EOR sign2);
        else
            result = FPRound(value1*value2, fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpmuladd/FPMulAdd

```
// FPMulAdd()
// ==========
//
// Calculates addend + op1*op2 with a single rounding.

bits(N) FPMulAdd(bits(N) addend, bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    rounding = FPRoundingMode(fpcr);
    (typeA,signA,valueA) = FPUnpack(addend, fpcr);
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    inf1 = (type1 == FPType_Infinity); zero1 = (type1 == FPType_Zero);
    inf2 = (type2 == FPType_Infinity); zero2 = (type2 == FPType_Zero);
    (done,result) = FPProcessNaNs3(typeA, type1, type2, addend, op1, op2, fpcr);

    if typeA == FPType_QNaN && ((inf1 && zero2) || (zero1 && inf2)) then
        result = FPDefaultNaN();
        FPProcessException(FPExc_InvalidOp, fpcr);

    if !done then
        infA = (typeA == FPType_Infinity);  zeroA = (typeA == FPType_Zero);

        // Determine sign and type product will have if it does not cause an Invalid
        // Operation.
        signP = sign1 EOR sign2;
        infP  = inf1 || inf2;
        zeroP = zero1 || zero2;

        // Non SNaN-generated Invalid Operation cases are multiplies of zero by infinity and
        // additions of opposite-signed infinities.
        if (inf1 && zero2) || (zero1 && inf2) || (infA && infP && signA != signP) then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);

        // Other cases involving infinities produce an infinity of the same sign.
        elsif (infA && signA == '0') || (infP && signP == '0') then
            result = FPInfinity('0');
        elsif (infA && signA == '1') || (infP && signP == '1') then
            result = FPInfinity('1');

        // Cases where the result is exactly zero and its sign is not determined by the
        // rounding mode are additions of same-signed zeros.
        elsif zeroA && zeroP && signA == signP then
            result = FPZero(signA);

        // Otherwise calculate numerical result and round it.
        else
            result_value = valueA + (value1 * value2);
            if result_value == 0.0 then  // Sign of exact zero result depends on rounding mode
                result_sign = if rounding == FPRounding_NEGINF then '1' else '0';
                result = FPZero(result_sign);
            else
                result = FPRound(result_value, fpcr);

    return result;
```

Library pseudocode for shared/functions/float/fpmuladdh/FPMulAddH

```
// FPMulAddH()
// ===========

bits(N) FPMulAddH(bits(N) addend, bits(N DIV 2) op1, bits(N DIV 2) op2, FPCRType fpcr)
    assert N IN {32,64};
    rounding = FPRoundingMode(fpcr);
    (typeA,signA,valueA) = FPUnpack(addend, fpcr);
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    inf1 = (type1 == FPType_Infinity); zero1 = (type1 == FPType_Zero);
    inf2 = (type2 == FPType_Infinity); zero2 = (type2 == FPType_Zero);
    (done,result) = FPProcessNaNs3H(typeA, type1, type2, addend, op1, op2, fpcr);
    if typeA == FPType_QNaN && ((inf1 && zero2) || (zero1 && inf2)) then
        result = FPDefaultNaN();
        FPProcessException(FPExc_InvalidOp, fpcr);
    if !done then
        infA = (typeA == FPType_Infinity); zeroA = (typeA == FPType_Zero);
        // Determine sign and type product will have if it does not cause an Invalid
        // Operation.
        signP = sign1 EOR sign2;
        infP = inf1 || inf2;
        zeroP = zero1 || zero2;
        // Non SNaN-generated Invalid Operation cases are multiplies of zero by infinity and
        // additions of opposite-signed infinities.
        if (inf1 && zero2) || (zero1 && inf2) || (infA && infP && signA != signP) then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);
        // Other cases involving infinities produce an infinity of the same sign.
        elsif (infA && signA == '0') || (infP && signP == '0') then
            result = FPInfinity('0');
        elsif (infA && signA == '1') || (infP && signP == '1') then
            result = FPInfinity('1');
        // Cases where the result is exactly zero and its sign is not determined by the
        // rounding mode are additions of same-signed zeros.
        elsif zeroA && zeroP && signA == signP then
            result = FPZero(signA);
        // Otherwise calculate numerical result and round it.
        else
            result_value = valueA + (value1 * value2);
            if result_value == 0.0 then // Sign of exact zero result depends on rounding mode
                result_sign = if rounding == FPRounding_NEGINF then '1' else '0';
                result = FPZero(result_sign);
            else
                result = FPRound(result_value, fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpmuladdh/FPProcessNaNs3H

```
// FPProcessNaNs3H()
// =================

(boolean, bits(N)) FPProcessNaNs3H(FPType type1, FPType type2, FPType type3, bits(N) op1, bits(N DIV 2) o
    assert N IN {32,64};
    bits(N) result;
    if type1 == FPType_SNaN then
        done = TRUE; result = FPProcessNaN(type1, op1, fpcr);
    elsif type2 == FPType_SNaN then
        done = TRUE; result = FPConvertNaN(FPProcessNaN(type2, op2, fpcr));
    elsif type3 == FPType_SNaN then
        done = TRUE; result = FPConvertNaN(FPProcessNaN(type3, op3, fpcr));
    elsif type1 == FPType_QNaN then
        done = TRUE; result = FPProcessNaN(type1, op1, fpcr);
    elsif type2 == FPType_QNaN then
        done = TRUE; result = FPConvertNaN(FPProcessNaN(type2, op2, fpcr));
    elsif type3 == FPType_QNaN then
        done = TRUE; result = FPConvertNaN(FPProcessNaN(type3, op3, fpcr));
    else
        done = FALSE; result = Zeros(); // 'Don't care' result
    return (done, result);
```

Library pseudocode for shared/functions/float/fpmulx/FPMulX

```
// FPMulX()
// ========

bits(N) FPMulX(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    bits(N) result;
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);
        inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);
        zero2 = (type2 == FPType_Zero);
        if (inf1 && zero2) || (zero1 && inf2) then
            result = FPTwo(sign1 EOR sign2);
        elsif inf1 || inf2 then
            result = FPInfinity(sign1 EOR sign2);
        elsif zero1 || zero2 then
            result = FPZero(sign1 EOR sign2);
        else
            result = FPRound(value1*value2, fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpneg/FPNeg

```
// FPNeg()
// =======

bits(N) FPNeg(bits(N) op)
    assert N IN {16,32,64};
    return NOT(op<N-1>) : op<N-2:0>;
```

Library pseudocode for shared/functions/float/fponepointfive/FPOnePointFive

```
// FPOnePointFive()
// ================

bits(N) FPOnePointFive(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp  = '0':Ones(E-1);
    frac = '1':Zeros(F-1);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/fpprocessexception/FPProcessException

```
// FPProcessException()
// ====================
//
// The 'fpcr' argument supplies FPCR control bits. Status information is
// updated directly in the FPSR where appropriate.

FPProcessException(FPExc exception, FPCRType fpcr)
    // Determine the cumulative exception bit number
    case exception of
        when FPExc_InvalidOp     cumul = 0;
        when FPExc_DivideByZero  cumul = 1;
        when FPExc_Overflow      cumul = 2;
        when FPExc_Underflow     cumul = 3;
        when FPExc_Inexact       cumul = 4;
        when FPExc_InputDenorm   cumul = 7;
    enable = cumul + 8;
    if fpcr<enable> == '1' then
        // Trapping of the exception enabled.
        // It is IMPLEMENTATION DEFINED whether the enable bit may be set at all, and
        // if so then how exceptions may be accumulated before calling FPTrappedException()
        // if so then how exceptions may be accumulated before calling FPTrapException()
        IMPLEMENTATION_DEFINED "floating-point trap handling";
    elsif UsingAArch32() then
        // Set the cumulative exception bit
        FPSCR<cumul> = '1';
    else
        // Set the cumulative exception bit
        FPSR<cumul> = '1';
    return;
```

Library pseudocode for shared/functions/float/fpprocessnan/FPProcessNaN

```
// FPProcessNaN()
// ==============

bits(N) FPProcessNaN(FPType fptype, bits(N) op, FPCRType fpcr)
    assert N IN {16,32,64};
    assert fptype IN {FPType_QNaN, FPType_SNaN};

    case N of
        when 16 topfrac =  9;
        when 32 topfrac = 22;
        when 64 topfrac = 51;

    result = op;
    if fptype == FPType_SNaN then
        result<topfrac> = '1';
        FPProcessException(FPExc_InvalidOp, fpcr);
    if fpcr.DN == '1' then  // DefaultNaN requested
        result = FPDefaultNaN();
    return result;
```

Library pseudocode for shared/functions/float/fpprocessnans/FPProcessNaNs

```
// FPProcessNaNs()
// ===============
//
// The boolean part of the return value says whether a NaN has been found and
// processed. The bits(N) part is only relevant if it has and supplies the
// result of the operation.
//
// The 'fpcr' argument supplies FPCR control bits. Status information is
// updated directly in the FPSR where appropriate.

(boolean, bits(N)) FPProcessNaNs(FPType type1, FPType type2,
                                 bits(N) op1, bits(N) op2,
                                 FPCRType fpcr)
    assert N IN {16,32,64};
    if type1 == FPType_SNaN then
        done = TRUE;  result = FPProcessNaN(type1, op1, fpcr);
    elsif type2 == FPType_SNaN then
        done = TRUE;  result = FPProcessNaN(type2, op2, fpcr);
    elsif type1 == FPType_QNaN then
        done = TRUE;  result = FPProcessNaN(type1, op1, fpcr);
    elsif type2 == FPType_QNaN then
        done = TRUE;  result = FPProcessNaN(type2, op2, fpcr);
    else
        done = FALSE;  result = Zeros();  // 'Don't care' result
    return (done, result);
```

Library pseudocode for shared/functions/float/fpprocessnans3/FPProcessNaNs3

```
// FPProcessNaNs3()
// ================
//
// The boolean part of the return value says whether a NaN has been found and
// processed. The bits(N) part is only relevant if it has and supplies the
// result of the operation.
//
// The 'fpcr' argument supplies FPCR control bits. Status information is
// updated directly in the FPSR where appropriate.

(boolean, bits(N)) FPProcessNaNs3(FPType type1, FPType type2, FPType type3,
                                  bits(N) op1, bits(N) op2, bits(N) op3,
                                  FPCRType fpcr)
    assert N IN {16,32,64};
    if type1 == FPType_SNaN then
        done = TRUE;  result = FPProcessNaN(type1, op1, fpcr);
    elsif type2 == FPType_SNaN then
        done = TRUE;  result = FPProcessNaN(type2, op2, fpcr);
    elsif type3 == FPType_SNaN then
        done = TRUE;  result = FPProcessNaN(type3, op3, fpcr);
    elsif type1 == FPType_QNaN then
        done = TRUE;  result = FPProcessNaN(type1, op1, fpcr);
    elsif type2 == FPType_QNaN then
        done = TRUE;  result = FPProcessNaN(type2, op2, fpcr);
    elsif type3 == FPType_QNaN then
        done = TRUE;  result = FPProcessNaN(type3, op3, fpcr);
    else
        done = FALSE;  result = Zeros();  // 'Don't care' result
    return (done, result);
```

Library pseudocode for shared/functions/float/fprecipestimate/FPRecipEstimate

```
// FPRecipEstimate()
// =================

bits(N) FPRecipEstimate(bits(N) operand, FPCRType fpcr)
    assert N IN {16,32,64};
    (fptype,sign,value) = FPUnpack(operand, fpcr);
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, operand, fpcr);
    elsif fptype == FPType_Infinity then
        result = FPZero(sign);
    elsif fptype == FPType_Zero then
        result = FPInfinity(sign);
        FPProcessException(FPExc_DivideByZero, fpcr);
    elsif (
            (N == 16 && Abs(value) < 2.0^-16) ||
            (N == 32 && Abs(value) < 2.0^-128) ||
            (N == 64 && Abs(value) < 2.0^-1024)
          ) then
        case FPRoundingMode(fpcr) of
            when FPRounding_TIEEVEN
                overflow_to_inf = TRUE;
            when FPRounding_POSINF
                overflow_to_inf = (sign == '0');
            when FPRounding_NEGINF
                overflow_to_inf = (sign == '1');
            when FPRounding_ZERO
                overflow_to_inf = FALSE;
        result = if overflow_to_inf then FPInfinity(sign) else FPMaxNormal(sign);
        FPProcessException(FPExc_Overflow, fpcr);
        FPProcessException(FPExc_Inexact, fpcr);
    elsif ((fpcr.FZ == '1' && N != 16) || (fpcr.FZ16 == '1' && N == 16))
          && (
               (N == 16 && Abs(value) >= 2.0^14) ||
               (N == 32 && Abs(value) >= 2.0^126) ||
               (N == 64 && Abs(value) >= 2.0^1022)
             ) then
        // Result flushed to zero of correct sign
        result = FPZero(sign);
        if UsingAArch32() then
            FPSCR.UFC = '1';
        else
            FPSR.UFC = '1';
    else
        // Scale to a fixed point value in the range 0.5 <= x < 1.0 in steps of 1/512, and
        // calculate result exponent. Scaled value has copied sign bit,
        // exponent = 1022 = double-precision biased version of -1,
        // fraction = original fraction
        case N of
            when 16
                fraction = operand<9:0> : Zeros(42);
                exp = UInt(operand<14:10>);
            when 32
                fraction = operand<22:0> : Zeros(29);
                exp = UInt(operand<30:23>);
            when 64
                fraction = operand<51:0>;
                exp = UInt(operand<62:52>);

        if exp == 0 then
            if fraction<51> == '0' then
                exp = -1;
                fraction = fraction<49:0>:'00';
            else
                fraction = fraction<50:0>:'0';

        integer scaled = UInt('1':fraction<51:44>);

        case N of
            when 16 result_exp =   29 - exp; // In range 29-30 = -1 to 29+1 = 30
            when 32 result_exp =  253 - exp; // In range 253-254 = -1 to 253+1 = 254
```

```
            when 64 result_exp = 2045 - exp; // In range 2045-2046 = -1 to 2045+1 = 2046

        // scaled is in range 256..511 representing a fixed-point number in range [0.5..1.0)
        estimate = RecipEstimate(scaled);

        // estimate is in the range 256..511 representing a fixed point result in the range [1.0..2.0)
        // Convert to scaled floating point result with copied sign bit,
        // high-order bits from estimate, and exponent calculated above.

        fraction = estimate<7:0> : Zeros(44);
        if result_exp == 0 then
            fraction = '1' : fraction<51:1>;
        elsif result_exp == -1 then
            fraction = '01' : fraction<51:2>;
            result_exp = 0;

        case N of
            when 16 result = sign : result_exp<N-12:0> : fraction<51:42>;
            when 32 result = sign : result_exp<N-25:0> : fraction<51:29>;
            when 64 result = sign : result_exp<N-54:0> : fraction<51:0>;

    return result;
```

Library pseudocode for shared/functions/float/fprecipestimate/RecipEstimate

```
// Compute estimate of reciprocal of 9-bit fixed-point number
//
// a is in range 256 .. 511 representing a number in the range 0.5 <= x < 1.0.
// result is in the range 256 .. 511 representing a number in the range in the range 1.0 to 511/256.

integer RecipEstimate(integer a)
    assert 256 <= a && a < 512;
    a = a*2+1; // round to nearest
    integer b = (2 ^ 19) DIV a;
    r = (b+1) DIV 2; // round to nearest
    assert 256 <= r && r < 512;
    return r;
```

Library pseudocode for shared/functions/float/fprecpx/FPRecpX

```
// FPRecpX()
// =========

bits(N) FPRecpX(bits(N) op, FPCRType fpcr)
    assert N IN {16,32,64};

    case N of
        when 16 esize =  5;
        when 32 esize =  8;
        when 64 esize = 11;

    bits(N)           result;
    bits(esize)       exp;
    bits(esize)       max_exp;
    bits(N-(esize+1)) frac = Zeros();

    case N of
        when 16 exp = op<10+esize-1:10>;
        when 32 exp = op<23+esize-1:23>;
        when 64 exp = op<52+esize-1:52>;

    max_exp = Ones(esize) - 1;

    (fptype,sign,value) = FPUnpack(op, fpcr);
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, op, fpcr);
    else
        if IsZero(exp) then // Zero and denormals
            result = sign:max_exp:frac;
        else // Infinities and normals
            result = sign:NOT(exp):frac;

    return result;
```

Library pseudocode for shared/functions/float/fpround/FPRound

```
// FPRound()
// =========
// Used by data processing and int/fixed <-> FP conversion instructions.
// For half-precision data it ignores AHP, and observes FZ16.

bits(N) FPRound(real op, FPCRType fpcr, FPRounding rounding)
    fpcr.AHP = '0';
    return FPRoundBase(op, fpcr, rounding);

// Convert a real number OP into an N-bit floating-point value using the
// supplied rounding mode RMODE.

bits(N) FPRoundBase(real op, FPCRType fpcr, FPRounding rounding)
    assert N IN {16,32,64};
    assert op != 0.0;
    assert rounding != FPRounding_TIEAWAY;
    bits(N) result;

    // Obtain format parameters - minimum exponent, numbers of exponent and fraction bits.
    if N == 16 then
        minimum_exp = -14;  E = 5;  F = 10;
    elsif N == 32 then
        minimum_exp = -126;  E = 8;  F = 23;
    else  // N == 64
        minimum_exp = -1022;  E = 11;  F = 52;

    // Split value into sign, unrounded mantissa and exponent.
    if op < 0.0 then
        sign = '1';  mantissa = -op;
    else
        sign = '0';  mantissa = op;
    exponent = 0;
    while mantissa < 1.0 do
        mantissa = mantissa * 2.0;  exponent = exponent - 1;
    while mantissa >= 2.0 do
        mantissa = mantissa / 2.0;  exponent = exponent + 1;

    // Deal with flush-to-zero.
    if ((fpcr.FZ == '1' && N != 16) || (fpcr.FZ16 == '1' && N == 16)) && exponent < minimum_exp then
        // Flush-to-zero never generates a trapped exception
        if UsingAArch32() then
            FPSCR.UFC = '1';
        else
            FPSR.UFC = '1';
        return FPZero(sign);

    // Start creating the exponent value for the result. Start by biasing the actual exponent
    // so that the minimum exponent becomes 1, lower values 0 (indicating possible underflow).
    biased_exp = Max(exponent - minimum_exp + 1, 0);
    if biased_exp == 0 then mantissa = mantissa / 2.0^(minimum_exp - exponent);

    // Get the unrounded mantissa as an integer, and the "units in last place" rounding error.
    int_mant = RoundDown(mantissa * 2.0^F);  // < 2.0^F if biased_exp == 0, >= 2.0^F if not
    error = mantissa * 2.0^F - Real(int_mant);

    // Underflow occurs if exponent is too small before rounding, and result is inexact or
    // the Underflow exception is trapped.
    if biased_exp == 0 && (error != 0.0 || fpcr.UFE == '1') then
        FPProcessException(FPExc_Underflow, fpcr);

    // Round result according to rounding mode.
    case rounding of
        when FPRounding_TIEEVEN
            round_up = (error > 0.5 || (error == 0.5 && int_mant<0> == '1'));
            overflow_to_inf = TRUE;
        when FPRounding_POSINF
            round_up = (error != 0.0 && sign == '0');
            overflow_to_inf = (sign == '0');
        when FPRounding_NEGINF
            round_up = (error != 0.0 && sign == '1');
```

```
            overflow_to_inf = (sign == '1');
        when FPRounding_ZERO, FPRounding_ODD
            round_up = FALSE;
            overflow_to_inf = FALSE;

    if round_up then
        int_mant = int_mant + 1;
        if int_mant == 2^F then      // Rounded up from denormalized to normalized
            biased_exp = 1;
        if int_mant == 2^(F+1) then  // Rounded up to next exponent
            biased_exp = biased_exp + 1;  int_mant = int_mant DIV 2;

    // Handle rounding to odd aka Von Neumann rounding
    if error != 0.0 && rounding == FPRounding_ODD then
        int_mant<0> = '1';

    // Deal with overflow and generate result.
    if N != 16 || fpcr.AHP == '0' then  // Single, double or IEEE half precision
        if biased_exp >= 2^E - 1 then
            result = if overflow_to_inf then FPInfinity(sign) else FPMaxNormal(sign);
            FPProcessException(FPExc_Overflow, fpcr);
            error = 1.0;  // Ensure that an Inexact exception occurs
        else
            result = sign : biased_exp<N-F-2:0> : int_mant<F-1:0>;
    else                                    // Alternative half precision
        if biased_exp >= 2^E then
            result = sign : Ones(N-1);
            FPProcessException(FPExc_InvalidOp, fpcr);
            error = 0.0;  // Ensure that an Inexact exception does not occur
        else
            result = sign : biased_exp<N-F-2:0> : int_mant<F-1:0>;

    // Deal with Inexact exception.
    if error != 0.0 then
        FPProcessException(FPExc_Inexact, fpcr);

    return result;

// FPRound()
// =========

bits(N) FPRound(real op, FPCRType fpcr)
    return FPRound(op, fpcr, FPRoundingMode(fpcr));
```

Library pseudocode for shared/functions/float/fpround/FPRoundCV

```
// FPRoundCV()
// ===========
// Used for FP <-> FP conversion instructions.
// For half-precision data ignores FZ16 and observes AHP.

bits(N) FPRoundCV(real op, FPCRType fpcr, FPRounding rounding)
    fpcr.FZ16 = '0';
    return FPRoundBase(op, fpcr, rounding);
```

Library pseudocode for shared/functions/float/fprounding/FPRounding

```
enumeration FPRounding  {FPRounding_TIEEVEN, FPRounding_POSINF,
                         FPRounding_NEGINF,  FPRounding_ZERO,
                         FPRounding_TIEAWAY, FPRounding_ODD};
```

Library pseudocode for shared/functions/float/fproundingmode/FPRoundingMode

```
// FPRoundingMode()
// ================

// Return the current floating-point rounding mode.

FPRounding FPRoundingMode(FPCRType fpcr)
    return FPDecodeRounding(fpcr.RMode);
```

Library pseudocode for shared/functions/float/fproundint/FPRoundInt

```
// FPRoundInt()
// ============

// Round OP to nearest integral floating point value using rounding mode ROUNDING.
// If EXACT is TRUE, set FPSR.IXC if result is not numerically equal to OP.

bits(N) FPRoundInt(bits(N) op, FPCRType fpcr, FPRounding rounding, boolean exact)
    assert rounding != FPRounding_ODD;
    assert N IN {16,32,64};

    // Unpack using FPCR to determine if subnormals are flushed-to-zero
    (fptype,sign,value) = FPUnpack(op, fpcr);

    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, op, fpcr);
    elsif fptype == FPType_Infinity then
        result = FPInfinity(sign);
    elsif fptype == FPType_Zero then
        result = FPZero(sign);
    else
        // extract integer component
        int_result = RoundDown(value);
        error = value - Real(int_result);

        // Determine whether supplied rounding mode requires an increment
        case rounding of
            when FPRounding_TIEEVEN
                round_up = (error > 0.5 || (error == 0.5 && int_result<0> == '1'));
            when FPRounding_POSINF
                round_up = (error != 0.0);
            when FPRounding_NEGINF
                round_up = FALSE;
            when FPRounding_ZERO
                round_up = (error != 0.0 && int_result < 0);
            when FPRounding_TIEAWAY
                round_up = (error > 0.5 || (error == 0.5 && int_result >= 0));

        if round_up then int_result = int_result + 1;

        // Convert integer value into an equivalent real value
        real_result = Real(int_result);

        // Re-encode as a floating-point value, result is always exact
        if real_result == 0.0 then
            result = FPZero(sign);
        else
            result = FPRound(real_result, fpcr, FPRounding_ZERO);

        // Generate inexact exceptions
        if error != 0.0 && exact then
            FPProcessException(FPExc_Inexact, fpcr);

    return result;
```

Library pseudocode for shared/functions/float/fproundintn/FPRoundIntN

```
// FPRoundIntN()
// =============

bits(N) FPRoundIntN(bits(N) op, FPCRType fpcr, FPRounding rounding, integer intsize)
    assert rounding != FPRounding_ODD;
    assert N IN {32,64};
    assert intsize IN {32, 64};
    integer exp;
    constant integer E = (if N == 32 then 8 else 11);
    constant integer F = N - (E + 1);

    // Unpack using FPCR to determine if subnormals are flushed-to-zero
    (fptype,sign,value) = FPUnpack(op, fpcr);

    if fptype IN {FPType_SNaN, FPType_QNaN, FPType_Infinity} then
        if N == 32 then
            exp = 126 + intsize;
            result = '1':exp<(E-1):0>:Zeros(F);
        else
            exp = 1022+intsize;
            result = '1':exp<(E-1):0>:Zeros(F);
        FPProcessException(FPExc_InvalidOp, fpcr);
    elsif fptype == FPType_Zero then
        result = FPZero(sign);
    else
        // Extract integer component
        int_result = RoundDown(value);
        error = value - Real(int_result);

        // Determine whether supplied rounding mode requires an increment
        case rounding of
            when FPRounding_TIEEVEN
                round_up = error > 0.5 || (error == 0.5 && int_result<0> == '1');
            when FPRounding_POSINF
                round_up = error != 0.0;
            when FPRounding_NEGINF
                round_up = FALSE;
            when FPRounding_ZERO
                round_up = error != 0.0 && int_result < 0;
            when FPRounding_TIEAWAY
                round_up = error > 0.5 || (error == 0.5 && int_result >= 0);

        if round_up then int_result = int_result + 1;

        if int_result > 2^(intsize-1)-1 || int_result < -1*2^(intsize-1) then
            if N == 32 then
                exp = 126 + intsize;
                result = '1':exp<(E-1):0>:Zeros(F);
            else
                exp = 1022 + intsize;
                result = '1':exp<(E-1):0>:Zeros(F);
            FPProcessException(FPExc_InvalidOp, fpcr);
            // this case shouldn't set Inexact
            error = 0.0;

        else
            // Convert integer value into an equivalent real value
            real_result = Real(int_result);

            // Re-encode as a floating-point value, result is always exact
            if real_result == 0.0 then
                result = FPZero(sign);
            else
                result = FPRound(real_result, fpcr, FPRounding_ZERO);

        // Generate inexact exceptions
        if error != 0.0 then
            FPProcessException(FPExc_Inexact, fpcr);

    return result;
```

Library pseudocode for shared/functions/float/fprsqrtestimate/FPRSqrtEstimate

```
// FPRSqrtEstimate()
// =================

bits(N) FPRSqrtEstimate(bits(N) operand, FPCRType fpcr)
    assert N IN {16,32,64};
    (fptype,sign,value) = FPUnpack(operand, fpcr);
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, operand, fpcr);
    elsif fptype == FPType_Zero then
        result = FPInfinity(sign);
        FPProcessException(FPExc_DivideByZero, fpcr);
    elsif sign == '1' then
        result = FPDefaultNaN();
        FPProcessException(FPExc_InvalidOp, fpcr);
    elsif fptype == FPType_Infinity then
        result = FPZero('0');
    else
        // Scale to a fixed-point value in the range 0.25 <= x < 1.0 in steps of 512, with the
        // evenness or oddness of the exponent unchanged, and calculate result exponent.
        // Scaled value has copied sign bit, exponent = 1022 or 1021 = double-precision
        // biased version of -1 or -2, fraction = original fraction extended with zeros.

        case N of
            when 16
                fraction = operand<9:0> : Zeros(42);
                exp = UInt(operand<14:10>);
            when 32
                fraction = operand<22:0> : Zeros(29);
                exp = UInt(operand<30:23>);
            when 64
                fraction = operand<51:0>;
                exp = UInt(operand<62:52>);

        if exp == 0 then
            while fraction<51> == '0' do
                fraction = fraction<50:0> : '0';
                exp = exp - 1;
            fraction = fraction<50:0> : '0';

        if exp<0> == '0' then
            scaled = UInt('1':fraction<51:44>);
        else
            scaled = UInt('01':fraction<51:45>);

        case N of
            when 16 result_exp = (  44 - exp) DIV 2;
            when 32 result_exp = ( 380 - exp) DIV 2;
            when 64 result_exp = (3068 - exp) DIV 2;

        estimate = RecipSqrtEstimate(scaled);

        // estimate is in the range 256..511 representing a fixed point result in the range [1.0..2.0)
        // Convert to scaled floating point result with copied sign bit and high-order
        // fraction bits, and exponent calculated above.
        case N of
            when 16 result = '0' : result_exp<N-12:0> : estimate<7:0>:Zeros( 2);
            when 32 result = '0' : result_exp<N-25:0> : estimate<7:0>:Zeros(15);
            when 64 result = '0' : result_exp<N-54:0> : estimate<7:0>:Zeros(44);
    return result;
```

Library pseudocode for shared/functions/float/fprsqrtestimate/RecipSqrtEstimate

```
// Compute estimate of reciprocal square root of 9-bit fixed-point number
//
// a is in range 128 .. 511 representing a number in the range 0.25 <= x < 1.0.
// result is in the range 256 .. 511 representing a number in the range in the range 1.0 to 511/256.

integer RecipSqrtEstimate(integer a)
    assert 128 <= a && a < 512;
    if a < 256 then // 0.25 .. 0.5
        a = a*2+1;     // a in units of 1/512 rounded to nearest
    else // 0.5 .. 1.0
        a = (a >> 1) << 1;   // discard bottom bit
        a = (a+1)*2;  // a in units of 1/256 rounded to nearest
    integer b = 512;
    while a*(b+1)*(b+1) < 2^28 do
        b = b+1;
    // b = largest b such that b < 2^14 / sqrt(a) do
    r = (b+1) DIV 2; // round to nearest
    assert 256 <= r && r < 512;
    return r;
```

Library pseudocode for shared/functions/float/fpsqrt/FPSqrt

```
// FPSqrt()
// ========

bits(N) FPSqrt(bits(N) op, FPCRType fpcr)
    assert N IN {16,32,64};
    (fptype,sign,value) = FPUnpack(op, fpcr);
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        result = FPProcessNaN(fptype, op, fpcr);
    elsif fptype == FPType_Zero then
        result = FPZero(sign);
    elsif fptype == FPType_Infinity && sign == '0' then
        result = FPInfinity(sign);
    elsif sign == '1' then
        result = FPDefaultNaN();
        FPProcessException(FPExc_InvalidOp, fpcr);
    else
        result = FPRound(Sqrt(value), fpcr);
    return result;
```

Library pseudocode for shared/functions/float/fpsub/FPSub

```
// FPSub()
// =======

bits(N) FPSub(bits(N) op1, bits(N) op2, FPCRType fpcr)
    assert N IN {16,32,64};
    rounding = FPRoundingMode(fpcr);
    (type1,sign1,value1) = FPUnpack(op1, fpcr);
    (type2,sign2,value2) = FPUnpack(op2, fpcr);
    (done,result) = FPProcessNaNs(type1, type2, op1, op2, fpcr);
    if !done then
        inf1 = (type1 == FPType_Infinity);
        inf2 = (type2 == FPType_Infinity);
        zero1 = (type1 == FPType_Zero);
        zero2 = (type2 == FPType_Zero);
        if inf1 && inf2 && sign1 == sign2 then
            result = FPDefaultNaN();
            FPProcessException(FPExc_InvalidOp, fpcr);
        elsif (inf1 && sign1 == '0') || (inf2 && sign2 == '1') then
            result = FPInfinity('0');
        elsif (inf1 && sign1 == '1') || (inf2 && sign2 == '0') then
            result = FPInfinity('1');
        elsif zero1 && zero2 && sign1 == NOT(sign2) then
            result = FPZero(sign1);
        else
            result_value = value1 - value2;
            if result_value == 0.0 then  // Sign of exact zero result depends on rounding mode
                result_sign = if rounding == FPRounding_NEGINF then '1' else '0';
                result = FPZero(result_sign);
            else
                result = FPRound(result_value, fpcr, rounding);
    return result;
```

Library pseudocode for shared/functions/float/fpthree/FPThree

```
// FPThree()
// =========

bits(N) FPThree(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp  = '1':Zeros(E-1);
    frac = '1':Zeros(F-1);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/fptofixed/FPToFixed

```
// FPToFixed()
// ===========

// Convert N-bit precision floating point OP to M-bit fixed point with
// FBITS fractional bits, controlled by UNSIGNED and ROUNDING.

bits(M) FPToFixed(bits(N) op, integer fbits, boolean unsigned, FPCRType fpcr, FPRounding rounding)
    assert N IN {16,32,64};
    assert M IN {16,32,64};
    assert fbits >= 0;
    assert rounding != FPRounding_ODD;

    // Unpack using fpcr to determine if subnormals are flushed-to-zero
    (fptype,sign,value) = FPUnpack(op, fpcr);

    // If NaN, set cumulative flag or take exception
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        FPProcessException(FPExc_InvalidOp, fpcr);

    // Scale by fractional bits and produce integer rounded towards minus-infinity
    value = value * 2.0^fbits;
    int_result = RoundDown(value);
    error = value - Real(int_result);

    // Determine whether supplied rounding mode requires an increment
    case rounding of
        when FPRounding_TIEEVEN
            round_up = (error > 0.5 || (error == 0.5 && int_result<0> == '1'));
        when FPRounding_POSINF
            round_up = (error != 0.0);
        when FPRounding_NEGINF
            round_up = FALSE;
        when FPRounding_ZERO
            round_up = (error != 0.0 && int_result < 0);
        when FPRounding_TIEAWAY
            round_up = (error > 0.5 || (error == 0.5 && int_result >= 0));

    if round_up then int_result = int_result + 1;

    // Generate saturated result and exceptions
    (result, overflow) = SatQ(int_result, M, unsigned);
    if overflow then
        FPProcessException(FPExc_InvalidOp, fpcr);
    elsif error != 0.0 then
        FPProcessException(FPExc_Inexact, fpcr);

    return result;
```

Library pseudocode for shared/functions/float/fptofixedjs/FPToFixedJS

```
// FPToFixedJS()
// =============

// Converts a double precision floating point input value
// to a signed integer, with rounding to zero.

(bits(N), bit)bits(N) FPToFixedJS(bits(M) op, FPCRType fpcr, boolean Is64)

    assert M == 64 && N == 32;

    // Unpack using fpcr to determine if subnormals are flushed-to-zero
    (fptype,sign,value) = FPUnpack(op, fpcr);

    Z = '1';
    // If NaN, set cumulative flag or take exception
    if fptype == FPType_SNaN || fptype == FPType_QNaN then
        FPProcessException(FPExc_InvalidOp, fpcr);
        Z = '0';

    int_result = RoundDown(value);
    error = value - Real(int_result);

    // Determine whether supplied rounding mode requires an increment

    round_it_up = (error != 0.0 && int_result < 0);
    if round_it_up then int_result = int_result + 1;

    if int_result < 0 then
        result = int_result - 2^32*RoundUp(Real(int_result)/Real(2^32));
    else
        result = int_result - 2^32*RoundDown(Real(int_result)/Real(2^32));

    // Generate exceptions
    if int_result < -(2^31) || int_result > (2^31)-1 then
        FPProcessException(FPExc_InvalidOp, fpcr);
        Z = '0';
    elsif error != 0.0 then
        FPProcessException(FPExc_Inexact, fpcr);
        Z = '0';
    elsif sign == '1' && value == 0.0 then
    if sign == '1'&& value == 0.0 then
        Z = '0';
    elsif sign == '0' && value == 0.0 && !
    if fptype ==IsZero(op<51:0>) then
        Z = '0';

    if fptype == FPType_Infinity then result = 0;

    return (result<N-1:0>, Z);    if Is64 then
        PSTATE.<N,Z,C,V> = '0':Z:'00';
    else
        FPSCR<31:28> = '0':Z:'00';
    return result<N-1:0>;
```

Library pseudocode for shared/functions/float/fptwo/FPTwo

```
// FPTwo()
// =======

bits(N) FPTwo(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp  = '1':Zeros(E-1);
    frac = Zeros(F);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/fptype/FPType

```
enumeration FPType      {FPType_Nonzero, FPType_Zero, FPType_Infinity,
                         FPType_QNaN, FPType_SNaN};
```

Library pseudocode for shared/functions/float/fpunpack/FPUnpack

```
// FPUnpack()
// ==========
//
// Used by data processing and int/fixed <-> FP conversion instructions.
// For half-precision data it ignores AHP, and observes FZ16.

(FPType, bit, real) FPUnpack(bits(N) fpval, FPCRType fpcr)
    fpcr.AHP = '0';
    (fp_type, sign, value) = FPUnpackBase(fpval, fpcr);
    return (fp_type, sign, value);
```

Library pseudocode for shared/functions/float/fpunpack/FPUnpackBase

```
// FPUnpackBase()
// ==============
//
// Unpack a floating-point number into its type, sign bit and the real number
// that it represents. The real number result has the correct sign for numbers
// and infinities, is very large in magnitude for infinities, and is 0.0 for
// NaNs. (These values are chosen to simplify the description of comparisons
// and conversions.)
//
// The 'fpcr' argument supplies FPCR control bits. Status information is
// updated directly in the FPSR where appropriate.

(FPType, bit, real) FPUnpackBase(bits(N) fpval, FPCRType fpcr)
    assert N IN {16,32,64};

    if N == 16 then
        sign   = fpval<15>;
        exp16  = fpval<14:10>;
        frac16 = fpval<9:0>;
        if IsZero(exp16) then
            // Produce zero if value is zero or flush-to-zero is selected
            if IsZero(frac16) || fpcr.FZ16 == '1' then
                fptype = FPType_Zero;  value = 0.0;
            else
                fptype = FPType_Nonzero;  value = 2.0^-14 * (Real(UInt(frac16)) * 2.0^-10);
        elsif IsOnes(exp16) && fpcr.AHP == '0' then  // Infinity or NaN in IEEE format
            if IsZero(frac16) then
                fptype = FPType_Infinity;  value = 2.0^1000000;
            else
                fptype = if frac16<9> == '1' then FPType_QNaN else FPType_SNaN;
                value = 0.0;
        else
            fptype = FPType_Nonzero;
            value = 2.0^(UInt(exp16)-15) * (1.0 + Real(UInt(frac16)) * 2.0^-10);

    elsif N == 32 then

        sign   = fpval<31>;
        exp32  = fpval<30:23>;
        frac32 = fpval<22:0>;
        if IsZero(exp32) then
            // Produce zero if value is zero or flush-to-zero is selected.
            if IsZero(frac32) || fpcr.FZ == '1' then
                fptype = FPType_Zero;  value = 0.0;
                if !IsZero(frac32) then  // Denormalized input flushed to zero
                    FPProcessException(FPExc_InputDenorm, fpcr);
            else
                fptype = FPType_Nonzero;  value = 2.0^-126 * (Real(UInt(frac32)) * 2.0^-23);
        elsif IsOnes(exp32) then
            if IsZero(frac32) then
                fptype = FPType_Infinity;  value = 2.0^1000000;
            else
                fptype = if frac32<22> == '1' then FPType_QNaN else FPType_SNaN;
                value = 0.0;
        else
            fptype = FPType_Nonzero;
            value = 2.0^(UInt(exp32)-127) * (1.0 + Real(UInt(frac32)) * 2.0^-23);

    else // N == 64

        sign   = fpval<63>;
        exp64  = fpval<62:52>;
        frac64 = fpval<51:0>;
        if IsZero(exp64) then
            // Produce zero if value is zero or flush-to-zero is selected.
            if IsZero(frac64) || fpcr.FZ == '1' then
                fptype = FPType_Zero;  value = 0.0;
                if !IsZero(frac64) then  // Denormalized input flushed to zero
                    FPProcessException(FPExc_InputDenorm, fpcr);
            else
```

```
                fptype = FPType_Nonzero;  value = 2.0^-1022 * (Real(UInt(frac64)) * 2.0^-52);
        elsif IsOnes(exp64) then
            if IsZero(frac64) then
                fptype = FPType_Infinity;  value = 2.0^1000000;
            else
                fptype = if frac64<51> == '1' then FPType_QNaN else FPType_SNaN;
                value = 0.0;
        else
            fptype = FPType_Nonzero;
            value = 2.0^(UInt(exp64)-1023) * (1.0 + Real(UInt(frac64)) * 2.0^-52);

    if sign == '1' then value = -value;
    return (fptype, sign, value);
```

Library pseudocode for shared/functions/float/fpunpack/FPUnpackCV

```
// FPUnpackCV()
// ============
//
// Used for FP <-> FP conversion instructions.
// For half-precision data ignores FZ16 and observes AHP.

(FPType, bit, real) FPUnpackCV(bits(N) fpval, FPCRType fpcr)
    fpcr.FZ16 = '0';
    (fp_type, sign, value) = FPUnpackBase(fpval, fpcr);
    return (fp_type, sign, value);
```

Library pseudocode for shared/functions/float/fpzero/FPZero

```
// FPZero()
// ========

bits(N) FPZero(bit sign)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - (E + 1);
    exp  = Zeros(E);
    frac = Zeros(F);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/float/vfpexpandimm/VFPExpandImm

```
// VFPExpandImm()
// ==============

bits(N) VFPExpandImm(bits(8) imm8)
    assert N IN {16,32,64};
    constant integer E = (if N == 16 then 5 elsif N == 32 then 8 else 11);
    constant integer F = N - E - 1;
    sign = imm8<7>;
    exp  = NOT(imm8<6>):Replicate(imm8<6>,E-3):imm8<5:4>;
    frac = imm8<3:0>:Zeros(F-4);
    return sign : exp : frac;
```

Library pseudocode for shared/functions/integer/AddWithCarry

```
// AddWithCarry()
// ==============
// Integer addition with carry input, returning result and NZCV flags

(bits(N), bits(4)) AddWithCarry(bits(N) x, bits(N) y, bit carry_in)
    integer unsigned_sum = UInt(x) + UInt(y) + UInt(carry_in);
    integer signed_sum = SInt(x) + SInt(y) + UInt(carry_in);
    bits(N) result = unsigned_sum<N-1:0>; // same value as signed_sum<N-1:0>
    bit n = result<N-1>;
    bit z = if IsZero(result) then '1' else '0';
    bit c = if UInt(result) == unsigned_sum then '0' else '1';
    bit v = if SInt(result) == signed_sum then '0' else '1';
    return (result, n:z:c:v);
```

Library pseudocode for shared/functions/memory/AArch64.BranchAddr

```
// AArch64.BranchAddr()
// ====================
// Return the virtual address with tag bits removed for storing to the program counter.

bits(64) AArch64.BranchAddr(bits(64) vaddress)
    assert !UsingAArch32();
    msbit = AddrTop(vaddress, TRUE, PSTATE.EL);
    if msbit == 63 then
        return vaddress;
    elsif (PSTATE.EL IN {EL0, EL1} || IsInHost()) && vaddress<msbit> == '1' then
        return SignExtend(vaddress<msbit:0>);
    else
        return ZeroExtend(vaddress<msbit:0>);
```

Library pseudocode for shared/functions/memory/AccType

```
enumeration AccType {AccType_NORMAL, AccType_VEC,         // Normal loads and stores
                     AccType_STREAM, AccType_VECSTREAM,   // Streaming loads and stores
                     AccType_ATOMIC, AccType_ATOMICRW,    // Atomic loads and stores
                     AccType_ORDERED, AccType_ORDEREDRW,  // Load-Acquire and Store-Release
                     AccType_ORDEREDATOMIC,               // Load-Acquire and Store-Release with atomic ac
                     AccType_ORDEREDATOMICRW,
                     AccType_LIMITEDORDERED,              // Load-LOAcquire and Store-LORelease
                     AccType_UNPRIV,                      // Load and store unprivileged
                     AccType_IFETCH,                      // Instruction fetch
                     AccType_PTW,                         // Page table walk
                     AccType_NONFAULT,                    // Non-faulting loads
                     AccType_CNOTFIRST,                   // Contiguous FF load, not first element
                     AccType_NV2REGISTER,                 // MRS/MSR instruction used at EL1 and which is
                                                          // to a memory access that uses the EL2 translat
                     // Other operations
                     AccType_DC,                          // Data cache maintenance
                     AccType_DC_UNPRIV,                   // Data cache maintenance instruction used at EL
                     AccType_IC,                          // Instruction cache maintenance
                     AccType_DCZVA,                       // DC ZVA instructions
                     AccType_AT};                         // Address translation
```

Library pseudocode for shared/functions/memory/AccessDescriptor

```
type AccessDescriptor is (
    AccType acctype,
    boolean transactional,
    MPAMinfo mpam,
    boolean page_table_walk,
    boolean secondstage,
    boolean s2fs1walk,
    integer level
)
```

Library pseudocode for shared/functions/memory/AddrTop

```
// AddrTop()
// =========
// Return the MSB number of a virtual address in the stage 1 translation regime for "el".
// If EL1 is using AArch64 then addresses from EL0 using AArch32 are zero-extended to 64 bits.

integer AddrTop(bits(64) address, boolean IsInstr, bits(2) el)
    assert HaveEL(el);
    regime = S1TranslationRegime(el);
    if ELUsingAArch32(regime) then
        // AArch32 translation regime.
        return 31;
    else
        // AArch64 translation regime.
        case regime of
            when EL1
                tbi = (if address<55> == '1' then TCR_EL1.TBI1 else TCR_EL1.TBI0);
                if HavePACExt() then
                    tbid = if address<55> == '1' then TCR_EL1.TBID1 else TCR_EL1.TBID0;
            when EL2
                if HaveVirtHostExt() && ELIsInHost(el) then
                    tbi = (if address<55> == '1' then TCR_EL2.TBI1 else TCR_EL2.TBI0);
                    if HavePACExt() then
                        tbid = if address<55> == '1' then TCR_EL2.TBID1 else TCR_EL2.TBID0;
                else
                    tbi = TCR_EL2.TBI;
                    if HavePACExt() then tbid = TCR_EL2.TBID;
            when EL3
                tbi = TCR_EL3.TBI;
                if HavePACExt() then tbid = TCR_EL3.TBID;

    return (if tbi == '1' && (!HavePACExt() || tbid == '0' || !IsInstr ) then 55 else 63);
```

Library pseudocode for shared/functions/memory/AddressDescriptor

```
type AddressDescriptor is (
    FaultRecord      fault,    // fault.statuscode indicates whether the address is valid
    MemoryAttributes mematttrs,
    FullAddress      paddress,
    bits(64)         vaddress
)
```

Library pseudocode for shared/functions/memory/Allocation

```
constant bits(2) MemHint_No = '00';     // No Read-Allocate, No Write-Allocate
constant bits(2) MemHint_WA = '01';     // No Read-Allocate, Write-Allocate
constant bits(2) MemHint_RA = '10';     // Read-Allocate, No Write-Allocate
constant bits(2) MemHint_RWA = '11';    // Read-Allocate, Write-Allocate
```

Library pseudocode for shared/functions/memory/BigEndian

```
// BigEndian()
// ===========

boolean BigEndian()
    boolean bigend;
    if UsingAArch32() then
        bigend = (PSTATE.E != '0');
    elsif PSTATE.EL == EL0 then
        bigend = (SCTLR[].E0E != '0');
    else
        bigend = (SCTLR[].EE != '0');
    return bigend;
```

Library pseudocode for shared/functions/memory/BigEndianReverse

```
// BigEndianReverse()
// ==================

bits(width) BigEndianReverse (bits(width) value)
    assert width IN {8, 16, 32, 64, 128};
    integer half = width DIV 2;
    if width == 8 then return value;
    return BigEndianReverse(value<half-1:0>) : BigEndianReverse(value<width-1:half>);
```

Library pseudocode for shared/functions/memory/Cacheability

```
constant bits(2) MemAttr_NC = '00';      // Non-cacheable
constant bits(2) MemAttr_WT = '10';      // Write-through
constant bits(2) MemAttr_WB = '11';      // Write-back
```

Library pseudocode for shared/functions/memory/CreateAccessDescriptor

```
// CreateAccessDescriptor()
// ========================

AccessDescriptor CreateAccessDescriptor(AccType acctype, boolean transactional)
    AccessDescriptor accdesc;
    accdesc.acctype = acctype;
    accdesc.transactional = transactional;
    accdesc.mpam = GenMPAMcurEL(acctype IN {AccType_IFETCH, AccType_IC});
    accdesc.page_table_walk = FALSE;
    return accdesc;

// CreateAccessDescriptor()
// ========================

AccessDescriptor CreateAccessDescriptor(AccType acctype)
    transactional = FALSE;
    return CreateAccessDescriptor(acctype, transactional);
```

Library pseudocode for shared/functions/memory/CreateAccessDescriptorPTW

```
// CreateAccessDescriptorPTW()
// ===========================

AccessDescriptorAccessDescriptor CreateAccessDescriptorPTW( CreateAccessDescriptorPTW(AccType acctype, bo
                                        boolean s2fs1walk, integer level)
    AccessDescriptor accdesc;
    accdesc.acctype = acctype;
    accdesc.transactional = FALSE;
    accdesc.mpam = GenMPAMcurEL(acctype IN {
    , AccType_ICAccessDescriptorAccType_IFETCH accdesc;
    accdesc.acctype = acctype;
    accdesc.transactional = FALSE;
    accdesc.mpam = GenMPAMcurEL(acctype IN {AccType_IFETCH, AccType_IC});
});
    accdesc.page_table_walk = TRUE;
    accdesc.s2fs1walk = s2fs1walk;
    accdesc.secondstage = s2fs1walk;
    accdesc.secondstage = secondstage;
    accdesc.level = level;
    return accdesc;
```

Library pseudocode for shared/functions/memory/DataMemoryBarrier

```
DataMemoryBarrier(MBReqDomain domain, MBReqTypes types);
```

Library pseudocode for shared/functions/memory/DataSynchronizationBarrier

```
DataSynchronizationBarrier(MBReqDomain domain, MBReqTypes types);
```

Library pseudocode for shared/functions/memory/DescriptorUpdate

```
type DescriptorUpdate is (
    boolean AF,                  // AF needs to be set
    boolean AP,                  // AP[2] / S2AP[2] will be modified
    AddressDescriptor descaddr   // Descriptor to be updated
)
```

Library pseudocode for shared/functions/memory/DeviceType

```
enumeration DeviceType {DeviceType_GRE, DeviceType_nGRE, DeviceType_nGnRE, DeviceType_nGnRnE};
```

Library pseudocode for shared/functions/memory/EffectiveTBI

```
// EffectiveTBI()
// ==============
// Returns the effective TBI in the AArch64 stage 1 translation regime for "el".

bit EffectiveTBI(bits(64) address, boolean IsInstr, bits(2) el)
    assert HaveEL(el);
    regime = S1TranslationRegime(el);
    assert(!ELUsingAArch32(regime));

    case regime of
        when EL1
            tbi = if address<55> == '1' then TCR_EL1.TBI1 else TCR_EL1.TBI0;
            if HavePACExt() then
                tbid = if address<55> == '1' then TCR_EL1.TBID1 else TCR_EL1.TBID0;
        when EL2
            if HaveVirtHostExt() && ELIsInHost(el) then
                tbi = if address<55> == '1' then TCR_EL2.TBI1 else TCR_EL2.TBI0;
                if HavePACExt() then
                    tbid = if address<55> == '1' then TCR_EL2.TBID1 else TCR_EL2.TBID0;
            else
                tbi = TCR_EL2.TBI;
                if HavePACExt() then tbid = TCR_EL2.TBID;
        when EL3
            tbi = TCR_EL3.TBI;
            if HavePACExt() then tbid = TCR_EL3.TBID;

    return (if tbi == '1' && (!HavePACExt() || tbid == '0' || !IsInstr) then '1' else '0');
```

Library pseudocode for shared/functions/memory/EffectiveTCMA

```
// EffectiveTCMA()
// ===============
// Returns the effective TCMA of a virtual address in the stage 1 translation regime for "el".

bit EffectiveTCMA(bits(64) address, bits(2) el)
    assert HaveEL(el);
    regime = S1TranslationRegime(el);
    assert(!ELUsingAArch32(regime));

    case regime of
        when EL1
            tcma = if address<55> == '1' then TCR_EL1.TCMA1 else TCR_EL1.TCMA0;
        when EL2
            if HaveVirtHostExt() && ELIsInHost(el) then
                tcma = if address<55> == '1' then TCR_EL2.TCMA1 else TCR_EL2.TCMA0;
            else
                tcma = TCR_EL2.TCMA;
        when EL3
            tcma = TCR_EL3.TCMA;

    return tcma;
```

Library pseudocode for shared/functions/memory/Fault

```
enumeration Fault {Fault_None,
                   Fault_AccessFlag,
                   Fault_Alignment,
                   Fault_Background,
                   Fault_Domain,
                   Fault_Permission,
                   Fault_Translation,
                   Fault_AddressSize,
                   Fault_SyncExternal,
                   Fault_SyncExternalOnWalk,
                   Fault_SyncParity,
                   Fault_SyncParityOnWalk,
                   Fault_AsyncParity,
                   Fault_AsyncExternal,
                   Fault_Debug,
                   Fault_TLBConflict,
                   Fault_BranchTarget,
                   Fault_HWUpdateAccessFlag,
                   Fault_Lockdown,
                   Fault_Exclusive,
                   Fault_ICacheMaint};
```

Library pseudocode for shared/functions/memory/FaultRecord

```
type FaultRecord is (Fault    statuscode,  // Fault Status
                     AccType  acctype,     // Type of access that faulted
                     FullAddress ipaddress, // Intermediate physical address
                     boolean  s2fs1walk,   // Is on a Stage 1 page table walk
                     boolean  write,       // TRUE for a write, FALSE for a read
                     integer  level,       // For translation, access flag and permission faults
                     bit      extflag,     // IMPLEMENTATION DEFINED syndrome for external aborts
                     boolean  secondstage, // Is a Stage 2 abort
                     bits(4)  domain,      // Domain number, AArch32 only
                     bits(2)  errortype,   // [Armv8.2 RAS] AArch32 AET or AArch64 SET
                     bits(4)  debugmoe)    // Debug method of entry, from AArch32 only

type PARTIDtype = bits(16);
type PMGtype = bits(8);

type MPAMinfo is (
     bit mpam_ns,
     PARTIDtype partid,
     PMGtype pmg
)
```

Library pseudocode for shared/functions/memory/FullAddress

```
type FullAddress is (
    bits(52) address,
    bit      NS                  // '0' = Secure, '1' = Non-secure
)
```

Library pseudocode for shared/functions/memory/Hint_Prefetch

```
// Signals the memory system that memory accesses of type HINT to or from the specified address are
// likely in the near future. The memory system may take some action to speed up the memory
// accesses when they do occur, such as pre-loading the the specified address into one or more
// caches as indicated by the innermost cache level target (0=L1, 1=L2, etc) and non-temporal hint
// stream. Any or all prefetch hints may be treated as a NOP. A prefetch hint must not cause a
// synchronous abort due to Alignment or Translation faults and the like. Its only effect on
// software-visible state should be on caches and TLBs associated with address, which must be
// accessible by reads, writes or execution, as defined in the translation regime of the current
// Exception level. It is guaranteed not to access Device memory.
// A Prefetch_EXEC hint must not result in an access that could not be performed by a speculative
// instruction fetch, therefore if all associated MMUs are disabled, then it cannot access any
// memory location that cannot be accessed by instruction fetches.
Hint_Prefetch(bits(64) address, PrefetchHint hint, integer target, boolean stream);
```

Library pseudocode for shared/functions/memory/MBReqDomain

```
enumeration MBReqDomain    {MBReqDomain_Nonshareable, MBReqDomain_InnerShareable,
                            MBReqDomain_OuterShareable, MBReqDomain_FullSystem};
```

Library pseudocode for shared/functions/memory/MBReqTypes

```
enumeration MBReqTypes     {MBReqTypes_Reads, MBReqTypes_Writes, MBReqTypes_All};
```

Library pseudocode for shared/functions/memory/MemAttrHints

```
type MemAttrHints is (
    bits(2) attrs,  // See MemAttr_*, Cacheability attributes
    bits(2) hints,  // See MemHint_*, Allocation hints
    boolean transient
)
```

Library pseudocode for shared/functions/memory/MemType

```
enumeration MemType {MemType_Normal, MemType_Device};
```

Library pseudocode for shared/functions/memory/MemoryAttributes

```
type MemoryAttributes is (
    MemType      memtype,

    DeviceType   device,     // For Device memory types
    MemAttrHints inner,      // Inner hints and attributes
    MemAttrHints outer,      // Outer hints and attributes
    boolean      tagged,     // Tagged access
    boolean      shareable,
    boolean      outershareable
)
```

Library pseudocode for shared/functions/memory/Permissions

```
type Permissions is (
    bits(3) ap,   // Access permission bits
    bit     xn,   // Execute-never bit
    bit     xxn,  // [Armv8.2] Extended execute-never bit for stage 2
    bit     pxn   // Privileged execute-never bit
)
```

Library pseudocode for shared/functions/memory/PrefetchHint

```
enumeration PrefetchHint {Prefetch_READ, Prefetch_WRITE, Prefetch_EXEC};
```

Library pseudocode for shared/functions/memory/SpeculativeStoreBypassBarrierToPA

```
SpeculativeStoreBypassBarrierToPA();
```

Library pseudocode for shared/functions/memory/SpeculativeStoreBypassBarrierToVA

```
SpeculativeStoreBypassBarrierToVA();
```

Library pseudocode for shared/functions/memory/TLBRecord

```
type TLBRecord is (
    Permissions       perms,
    bit               nG,             // '0' = Global, '1' = not Global
    bits(4)           domain,         // AArch32 only
    bit               GP,             // Guarded Page
    boolean           contiguous,     // Contiguous bit from page table
    integer           level,          // AArch32 Short-descriptor format: Indicates Section/Page
    integer           blocksize,      // Describes size of memory translated in KBytes
    DescriptorUpdate  descupdate,     // [Armv8.1] Context for h/w update of table descriptor
    bit               CnP,            // [Armv8.2] TLB entry can be shared between different PEs
    AddressDescriptor addrdesc
)
```

Library pseudocode for shared/functions/memory/_Mem

```
// These two _Mem[] accessors are the hardware operations which perform single-copy atomic,
// aligned, little-endian memory accesses of size bytes from/to the underlying physical
// memory array of bytes.
//
// The functions address the array using desc.paddress which supplies:
// * A 52-bit physical address
// * A single NS bit to select between Secure and Non-secure parts of the array.
//
// The accdesc descriptor describes the access type: normal, exclusive, ordered, streaming,
// etc and other parameters required to access the physical memory or for setting syndrome
// register in the event of an external abort.
bits(8*size) _Mem[AddressDescriptor desc, integer size, AccessDescriptor accdesc];

_Mem[AddressDescriptor desc, integer size, AccessDescriptor accdesc] = bits(8*size) value;
```

Library pseudocode for shared/functions/mpam/DefaultMPAMinfo

```
// DefaultMPAMinfo
// ===============
// Returns default MPAM info.  If secure is TRUE return default Secure
// MPAMinfo, otherwise return default Non-secure MPAMinfo.

MPAMinfo DefaultMPAMinfo(boolean secure)
    MPAMinfo DefaultInfo;
    DefaultInfo.mpam_ns = if secure then '0' else '1';
    DefaultInfo.partid  = DefaultPARTID;
    DefaultInfo.pmg     = DefaultPMG;
    return DefaultInfo;
```

Library pseudocode for shared/functions/mpam/DefaultPARTID

```
constant PARTIDtype DefaultPARTID = 0<15:0>;
```

Library pseudocode for shared/functions/mpam/DefaultPMG

```
constant PMGtype    DefaultPMG = 0<7:0>;
```

Library pseudocode for shared/functions/mpam/GenMPAMcurEL

```
// GenMPAMcurEL
// ============
// Returns MPAMinfo for the current EL and security state.
// InD is TRUE instruction access and FALSE otherwise.
// May be called if MPAM is not implemented (but in an version that supports
// MPAM), MPAM is disabled, or in AArch32.  In AArch32, convert the mode to
// EL if can and use that to drive MPAM information generation.  If mode
// cannot be converted, MPAM is not implemented, or MPAM is disabled return
// default MPAM information for the current security state.

MPAMinfo GenMPAMcurEL(boolean InD)
    bits(2) mpamel;
    boolean validEL;
    boolean secure = IsSecure();
    if HaveMPAMExt() && MPAMisEnabled() then
        if UsingAArch32() then
            (validEL, mpamel) = ELFromM32(PSTATE.M);
        else
            validEL = TRUE;
            mpamel = PSTATE.EL;
        if validEL then
            return genMPAM(UInt(mpamel), InD, secure);
    return DefaultMPAMinfo(secure);
```

Library pseudocode for shared/functions/mpam/MAP_vPARTID

```
// MAP_vPARTID
// ===========
// Performs conversion of virtual PARTID into physical PARTID
// Contains all of the error checking and implementation
// choices for the conversion.

(PARTIDtype, boolean) MAP_vPARTID(PARTIDtype vpartid)
    // should not ever be called if EL2 is not implemented
    // or is implemented but not enabled in the current
    // security state.
    PARTIDtype ret;
    boolean err;
    integer virt    = UInt( vpartid );
    integer vmprmax = UInt( MPAMIDR_EL1.VPMR_MAX );

    // vpartid_max is largest vpartid supported
    integer vpartid_max = 4 * vmprmax + 3;

    // One of many ways to reduce vpartid to value less than vpartid_max.
    if virt > vpartid_max then
        virt = virt MOD (vpartid_max+1);

    // Check for valid mapping entry.
    if MPAMVPMV_EL2<virt> == '1' then
        // vpartid has a valid mapping so access the map.
        ret = mapvpmw(virt);
        err = FALSE;

    // Is the default virtual PARTID valid?
    elsif MPAMVPMV_EL2<0> == '1' then
        // Yes, so use default mapping for vpartid == 0.
        ret = MPAMVPM0_EL2<0 +: 16>;
        err = FALSE;

    // Neither is valid so use default physical PARTID.
    else
        ret = DefaultPARTID;
        err = TRUE;

    // Check that the physical PARTID is in-range.
    // This physical PARTID came from a virtual mapping entry.
    integer partid_max = UInt( MPAMIDR_EL1.PARTID_MAX );
    if UInt(ret) > partid_max then
        // Out of range, so return default physical PARTID
        ret = DefaultPARTID;
        err = TRUE;
    return (ret, err);
```

Library pseudocode for shared/functions/mpam/MPAMisEnabled

```
// MPAMisEnabled
// =============
// Returns TRUE if MPAMisEnabled.

boolean MPAMisEnabled()
    el = HighestEL();
    case el of
        when EL3 return MPAM3_EL3.MPAMEN == '1';
        when EL2 return MPAM2_EL2.MPAMEN == '1';
        when EL1 return MPAM1_EL1.MPAMEN == '1';
```

Library pseudocode for shared/functions/mpam/MPAMisVirtual

```
// MPAMisVirtual
// =============
// Returns TRUE if MPAM is configured to be virtual at EL.

boolean MPAMisVirtual(integer el)
    return ( MPAMIDR_EL1.HAS_HCR == '1' &&     return (MPAMIDR_EL1.HAS_HCR == '1' && EL2Enabled() &&
             ( HCR_EL2.E2H == '0' || HCR_EL2.TGE == '0' ) &&
            (( el == 0 && MPAMHCR_EL2.EL0_VPMEN == '1' ) ||
             ( el == 1 && MPAMHCR_EL2.EL1_VPMEN == '1')));
```

Library pseudocode for shared/functions/mpam/genMPAM

```
// genMPAM
// =======
// Returns MPAMinfo for exception level el.
// If InD is TRUE returns MPAM information using PARTID_I and PMG_I fields
// of MPAMel_ELx register and otherwise using PARTID_D and PMG_D fields.
// Produces a Secure PARTID if Secure is TRUE and a Non-secure PARTID otherwise.

MPAMinfo genMPAM(integer el, boolean InD, boolean secure)
    MPAMinfo returnInfo;
    PARTIDtype partidel;
    boolean perr;
    boolean gstplk = (el == 0 && EL2Enabled() &&
                      MPAMHCR_EL2.GSTAPP_PLK == '1' && HCR_EL2.TGE == '0');
    integer eff_el = if gstplk then 1 else el;
    (partidel, perr) = genPARTID(eff_el, InD);
    PMGtype groupel  = genPMG(eff_el, InD, perr);
    returnInfo.mpam_ns = if secure then '0' else '1';
    returnInfo.partid  = partidel;
    returnInfo.pmg     = groupel;
    return returnInfo;
```

Library pseudocode for shared/functions/mpam/genMPAMel

```
// genMPAMel
// =========
// Returns MPAMinfo for specified EL in the current security state.
// InD is TRUE for instruction access and FALSE otherwise.

MPAMinfo genMPAMel(bits(2) el, boolean InD)
    boolean secure = IsSecure();
    if HaveMPAMExt() && MPAMisEnabled() then
        return genMPAM(UInt(el), InD, secure);
    return DefaultMPAMinfo(secure);
```

Library pseudocode for shared/functions/mpam/genPARTID

```
// genPARTID
// =========
// Returns physical PARTID and error boolean for exception level el.
// If InD is TRUE then PARTID is from MPAMel_ELx.PARTID_I and
// otherwise from MPAMel_ELx.PARTID_D.

(PARTIDtype, boolean) genPARTID(integer el, boolean InD)
    PARTIDtype partidel = getMPAM_PARTID(el, InD);

    integer partid_max = UInt(MPAMIDR_EL1.PARTID_MAX);
    if UInt(partidel) > partid_max then
        return (DefaultPARTID, TRUE);

    if MPAMisVirtual(el) then
        return MAP_vPARTID(partidel);
    else
        return (partidel, FALSE);
```

Library pseudocode for shared/functions/mpam/genPMG

```
// genPMG
// ======
// Returns PMG for exception level el and I- or D-side (InD).
// If PARTID generation (genPARTID) encountered an error, genPMG() should be
// called with partid_err as TRUE.

PMGtype genPMG(integer el, boolean InD, boolean partid_err)
    integer pmg_max = UInt(MPAMIDR_EL1.PMG_MAX);

    // It is CONSTRAINED UNPREDICTABLE whether partid_err forces PMG to
    // use the default or if it uses the PMG from getMPAM_PMG.
    if partid_err then
        return DefaultPMG;
    PMGtype groupel = getMPAM_PMG(el, InD);
    if UInt(groupel) <= pmg_max then
        return groupel;
    return DefaultPMG;
```

Library pseudocode for shared/functions/mpam/getMPAM_PARTID

```
// getMPAM_PARTID
// ==============
// Returns a PARTID from one of the MPAMn_ELx registers.
// MPAMn selects the MPAMn_ELx register used.
// If InD is TRUE, selects the PARTID_I field of that
// register.  Otherwise, selects the PARTID_D field.

PARTIDtype getMPAM_PARTID(integer MPAMn, boolean InD)
    PARTIDtype partid;
    boolean el2avail = EL2Enabled();

    if InD then
        case MPAMn of
            when 3 partid = MPAM3_EL3.PARTID_I;
            when 2 partid = if el2avail then MPAM2_EL2.PARTID_I else Zeros();
            when 1 partid = MPAM1_EL1.PARTID_I;
            when 0 partid = MPAM0_EL1.PARTID_I;
            otherwise partid = PARTIDtype UNKNOWN;
    else
        case MPAMn of
            when 3 partid = MPAM3_EL3.PARTID_D;
            when 2 partid = if el2avail then MPAM2_EL2.PARTID_D else Zeros();
            when 1 partid = MPAM1_EL1.PARTID_D;
            when 0 partid = MPAM0_EL1.PARTID_D;
            otherwise partid = PARTIDtype UNKNOWN;
    return partid;
```

Library pseudocode for shared/functions/mpam/getMPAM_PMG

```
// getMPAM_PMG
// ===========
// Returns a PMG from one of the MPAMn_ELx registers.
// MPAMn selects the MPAMn_ELx register used.
// If InD is TRUE, selects the PMG_I field of that
// register.  Otherwise, selects the PMG_D field.

PMGtype getMPAM_PMG(integer MPAMn, boolean InD)
    PMGtype pmg;
    boolean el2avail = EL2Enabled();

    if InD then
        case MPAMn of
            when 3 pmg = MPAM3_EL3.PMG_I;
            when 2 pmg = if el2avail then MPAM2_EL2.PMG_I else Zeros();
            when 1 pmg = MPAM1_EL1.PMG_I;
            when 0 pmg = MPAM0_EL1.PMG_I;
            otherwise pmg = PMGtype UNKNOWN;
    else
        case MPAMn of
            when 3 pmg = MPAM3_EL3.PMG_D;
            when 2 pmg = if el2avail then MPAM2_EL2.PMG_D else Zeros();
            when 1 pmg = MPAM1_EL1.PMG_D;
            when 0 pmg = MPAM0_EL1.PMG_D;
            otherwise pmg = PMGtype UNKNOWN;
    return pmg;
```

Library pseudocode for shared/functions/mpam/mapvpmw

```
// mapvpmw
// =======
// Map a virtual PARTID into a physical PARTID using
// the MPAMVPMn_EL2 registers.
// vpartid is now assumed in-range and valid (checked by caller)
// returns physical PARTID from mapping entry.

PARTIDtype mapvpmw(integer vpartid)
    bits(64) vpmw;
    integer wd = vpartid DIV 4;
    case wd of
        when 0 vpmw = MPAMVPM0_EL2;
        when 1 vpmw = MPAMVPM1_EL2;
        when 2 vpmw = MPAMVPM2_EL2;
        when 3 vpmw = MPAMVPM3_EL2;
        when 4 vpmw = MPAMVPM4_EL2;
        when 5 vpmw = MPAMVPM5_EL2;
        when 6 vpmw = MPAMVPM6_EL2;
        when 7 vpmw = MPAMVPM7_EL2;
        otherwise vpmw = Zeros(64);
    // vpme_lsb selects LSB of field within register
    integer vpme_lsb = (vpartid REM 4) * 16;
    return vpmw<vpme_lsb +: 16>;
```

Library pseudocode for shared/functions/registers/BranchTo

```
// BranchTo()
// ==========

// Set program counter to a new address, with a branch type
// In AArch64 state the address might include a tag in the top eight bits.

BranchTo(bits(N) target, BranchType branch_type)
    Hint_Branch(branch_type);
    if N == 32 then
        assert UsingAArch32();
        _PC = ZeroExtend(target);
    else
        assert N == 64 && !UsingAArch32();
        _PC = AArch64.BranchAddr(target<63:0>);
    return;
```

Library pseudocode for shared/functions/registers/BranchToAddr

```
// BranchToAddr()
// ==============

// Set program counter to a new address, with a branch type
// In AArch64 state the address does not include a tag in the top eight bits.

BranchToAddr(bits(N) target, BranchType branch_type)
    Hint_Branch(branch_type);
    if N == 32 then
        assert UsingAArch32();
        _PC = ZeroExtend(target);
    else
        assert N == 64 && !UsingAArch32();
        _PC = target<63:0>;
    return;
```

Library pseudocode for shared/functions/registers/BranchType

```
enumeration BranchType {
    BranchType_DIRCALL,     // Direct Branch with link
    BranchType_INDCALL,     // Indirect Branch with link
    BranchType_ERET,        // Exception return (indirect)
    BranchType_DBGEXIT,     // Exit from Debug state
    BranchType_RET,         // Indirect branch with function return hint
    BranchType_DIR,         // Direct branch
    BranchType_INDIR,       // Indirect branch
    BranchType_EXCEPTION,   // Exception entry
    BranchType_TMFAIL,      // Transaction failure
    BranchType_RESET,       // Reset
    BranchType_UNKNOWN};    // Other
```

Library pseudocode for shared/functions/registers/Hint_Branch

```
// Report the hint passed to BranchTo() and BranchToAddr(), for consideration when processing
// the next instruction.
Hint_Branch(BranchType hint);
```

Library pseudocode for shared/functions/registers/NextInstrAddr

```
// Return address of the sequentially next instruction.
bits(N) NextInstrAddr();
```

Library pseudocode for shared/functions/registers/ResetExternalDebugRegisters

```
// Reset the External Debug registers in the Core power domain.
ResetExternalDebugRegisters(boolean cold_reset);
```

Library pseudocode for shared/functions/registers/ThisInstrAddr

```
// ThisInstrAddr()
// ===============
// Return address of the current instruction.

bits(N) ThisInstrAddr()
    assert N == 64 || (N == 32 && UsingAArch32());
    return _PC<N-1:0>;
```

Library pseudocode for shared/functions/registers/_PC

```
bits(64) _PC;
```

Library pseudocode for shared/functions/registers/_R

```
array bits(64) _R[0..30];
```

Library pseudocode for shared/functions/sysregisters/SPSR

```
// SPSR[] - non-assignment form
// ============================

bits(32) SPSR[]
    bits(32) result;
    if UsingAArch32() then
        case PSTATE.M of
            when M32_FIQ      result = SPSR_fiq;
            when M32_IRQ      result = SPSR_irq;
            when M32_Svc      result = SPSR_svc;
            when M32_Monitor  result = SPSR_mon;
            when M32_Abort    result = SPSR_abt;
            when M32_Hyp      result = SPSR_hyp;
            when M32_Undef    result = SPSR_und;
            otherwise         Unreachable();
    else
        case PSTATE.EL of
            when EL1          result = SPSR_EL1;
            when EL2          result = SPSR_EL2;
            when EL3          result = SPSR_EL3;
            otherwise         Unreachable();
    return result;

// SPSR[] - assignment form
// ========================

SPSR[] = bits(32) value
    if UsingAArch32() then
        case PSTATE.M of
            when M32_FIQ      SPSR_fiq = value;
            when M32_IRQ      SPSR_irq = value;
            when M32_Svc      SPSR_svc = value;
            when M32_Monitor  SPSR_mon = value;
            when M32_Abort    SPSR_abt = value;
            when M32_Hyp      SPSR_hyp = value;
            when M32_Undef    SPSR_und = value;
            otherwise         Unreachable();
    else
        case PSTATE.EL of
            when EL1          SPSR_EL1 = value;
            when EL2          SPSR_EL2 = value;
            when EL3          SPSR_EL3 = value;
            otherwise         Unreachable();
    return;
```

Library pseudocode for shared/functions/system/ArchVersion

```
enumeration ArchVersion {
    ARMv8p0
    , ARMv8p1
    , ARMv8p2
    , ARMv8p3
    , ARMv8p4
    , ARMv8p5
};
```

Library pseudocode for shared/functions/system/BranchTargetCheck

```
// BranchTargetCheck()
// ===================
// This function is executed checks if the current instruction is a valid target for a branch
// taken into, or inside, a guarded page. It is executed on every cycle once the current
// instruction has been decoded and the values of InGuardedPage and BTypeCompatible have been
// determined for the current instruction.

BranchTargetCheck()
    assert HaveBTIExt() && !UsingAArch32();

    // The branch target check considers two state variables:
    // * InGuardedPage, which is evaluated during instruction fetch.
    // * BTypeCompatible, which is evaluated during instruction decode.
    if InGuardedPage && PSTATE.BTYPE != '00' && !BTypeCompatible && !Halted() then
        bits(64) pc = ThisInstrAddr();
        AArch64.BranchTargetException(pc<51:0>);

    boolean branch_instr = AArch64.ExecutingBROrBLROrRetInstr();
    boolean bti_instr    = AArch64.ExecutingBTIInstr();

    // PSTATE.BTYPE defaults to 00 for instructions that do not explictly set BTYPE.
    if !(branch_instr || bti_instr) then
        BTypeNext = '00';
```

Library pseudocode for shared/functions/system/ClearEventRegister

```
// ClearEventRegister()
// ====================
// Clear the Event Register of this PE

ClearEventRegister()
    EventRegister = '0';
    return;
```

Library pseudocode for shared/functions/system/ClearPendingPhysicalSError

```
// Clear a pending physical SError interrupt
ClearPendingPhysicalSError();
```

Library pseudocode for shared/functions/system/ClearPendingVirtualSError

```
// Clear a pending virtual SError interrupt
ClearPendingVirtualSError();
```

Library pseudocode for shared/functions/system/ConditionHolds

```
// ConditionHolds()
// ================
// Return TRUE iff COND currently holds

boolean ConditionHolds(bits(4) cond)
    // Evaluate base condition.
    case cond<3:1> of
        when '000' result = (PSTATE.Z == '1');                          // EQ or NE
        when '001' result = (PSTATE.C == '1');                          // CS or CC
        when '010' result = (PSTATE.N == '1');                          // MI or PL
        when '011' result = (PSTATE.V == '1');                          // VS or VC
        when '100' result = (PSTATE.C == '1' && PSTATE.Z == '0');       // HI or LS
        when '101' result = (PSTATE.N == PSTATE.V);                     // GE or LT
        when '110' result = (PSTATE.N == PSTATE.V && PSTATE.Z == '0');  // GT or LE
        when '111' result = TRUE;                                       // AL

    // Condition flag values in the set '111x' indicate always true
    // Otherwise, invert condition if necessary.
    if cond<0> == '1' && cond != '1111' then
        result = !result;

    return result;
```

Library pseudocode for shared/functions/system/ConsumptionOfSpeculativeDataBarrier

```
ConsumptionOfSpeculativeDataBarrier();
```

Library pseudocode for shared/functions/system/CurrentInstrSet

```
// CurrentInstrSet()
// =================

InstrSet CurrentInstrSet()

    if UsingAArch32() then
        result = if PSTATE.T == '0' then InstrSet_A32 else InstrSet_T32;
        // PSTATE.J is RES0. Implementation of T32EE or Jazelle state not permitted.
    else
        result = InstrSet_A64;
    return result;
```

Library pseudocode for shared/functions/system/CurrentPL

```
// CurrentPL()
// ===========

PrivilegeLevel CurrentPL()
    return PLOfEL(PSTATE.EL);
```

Library pseudocode for shared/functions/system/EL0

```
constant bits(2) EL3 = '11';
constant bits(2) EL2 = '10';
constant bits(2) EL1 = '01';
constant bits(2) EL0 = '00';
```

Library pseudocode for shared/functions/system/EL2Enabled

```
// EL2Enabled()
// ============
// Returns TRUE if EL2 is present and executing
// - with SCR_EL3.NS==1 when Non-secure EL2 is implemented, or
// - with SCR_EL3.NS==0 when Secure EL2 is implemented and enabled, or
// - when EL3 is not implemented.

boolean EL2Enabled()
    return HaveEL(EL2) && (!HaveEL(EL3) || SCR_EL3.NS == '1' || IsSecureEL2Enabled());
```

Library pseudocode for shared/functions/system/ELFromM32

```
// ELFromM32()
// ===========

(boolean,bits(2)) ELFromM32(bits(5) mode)
    // Convert an AArch32 mode encoding to an Exception level.
    // Returns (valid,EL):
    //   'valid' is TRUE if 'mode<4:0>' encodes a mode that is both valid for this implementation
    //           and the current value of SCR.NS/SCR_EL3.NS.
    //   'EL'    is the Exception level decoded from 'mode'.
    bits(2) el;
    boolean valid = !BadMode(mode);  // Check for modes that are not valid for this implementation
    case mode of
        when M32_Monitor
            el = EL3;
        when M32_Hyp
            el = EL2;
            valid = valid && (!HaveEL(EL3) || SCR_GEN[].NS == '1');
        when M32_FIQ, M32_IRQ, M32_Svc, M32_Abort, M32_Undef, M32_System
            // If EL3 is implemented and using AArch32, then these modes are EL3 modes in Secure
            // state, and EL1 modes in Non-secure state. If EL3 is not implemented or is using
            // AArch64, then these modes are EL1 modes.
            el = (if HaveEL(EL3) && HighestELUsingAArch32() && SCR.NS == '0' then EL3 else EL1);
        when M32_User
            el = EL0;
        otherwise
            valid = FALSE;           // Passed an illegal mode value
    if !valid then el = bits(2) UNKNOWN;
    return (valid, el);
```

Library pseudocode for shared/functions/system/ELFromSPSR

```
// ELFromSPSR()
// ============

// Convert an SPSR value encoding to an Exception level.
// Returns (valid,EL):
//   'valid' is TRUE if 'spsr<4:0>' encodes a valid mode for the current state.
//   'EL'    is the Exception level decoded from 'spsr'.

(boolean,bits(2)) ELFromSPSR(bits(32) spsr)
    if spsr<4> == '0' then                      // AArch64 state
        el = spsr<3:2>;
        if HighestELUsingAArch32() then         // No AArch64 support
            valid = FALSE;
        elsif !HaveEL(el) then                  // Exception level not implemented
            valid = FALSE;
        elsif spsr<1> == '1' then               // M[1] must be 0
            valid = FALSE;
        elsif el == EL0 && spsr<0> == '1' then  // for EL0, M[0] must be 0
            valid = FALSE;
        elsif el == EL2 && HaveEL(EL3) && !IsSecureEL2Enabled() && SCR_EL3.NS == '0' then
            valid = FALSE;                      // Unless Secure EL2 is enabled, EL2 only valid in Non-se
        else
            valid = TRUE;
    elsif HaveAnyAArch32() then                // AArch32 state
        (valid, el) = ELFromM32(spsr<4:0>);
    else
        valid = FALSE;

    if !valid then el = bits(2) UNKNOWN;
    return (valid,el);
```

Library pseudocode for shared/functions/system/ELIsInHost

```
// ELIsInHost()
// ============

boolean ELIsInHost(bits(2) el)
    return ((IsSecureEL2Enabled() || !IsSecureBelowEL3()) && HaveVirtHostExt() && !ELUsingAArch32(EL2) &&
            HCR_EL2.E2H == '1' && (el == EL2 || (el == EL0 && HCR_EL2.TGE == '1')));
```

Library pseudocode for shared/functions/system/ELStateUsingAArch32

```
// ELStateUsingAArch32()
// =====================

boolean ELStateUsingAArch32(bits(2) el, boolean secure)
    // See ELStateUsingAArch32K() for description. Must only be called in circumstances where
    // result is valid (typically, that means 'el IN {EL1,EL2,EL3}').
    (known, aarch32) = ELStateUsingAArch32K(el, secure);
    assert known;
    return aarch32;
```

Library pseudocode for shared/functions/system/ELStateUsingAArch32K

```
// ELStateUsingAArch32K()
// ======================

(boolean,boolean) ELStateUsingAArch32K(bits(2) el, boolean secure)
    // Returns (known, aarch32):
    //   'known'   is FALSE for EL0 if the current Exception level is not EL0 and EL1 is
    //             using AArch64, since it cannot determine the state of EL0; TRUE otherwise.
    //   'aarch32' is TRUE if the specified Exception level is using AArch32; FALSE otherwise.
    if !HaveAArch32EL(el) then
        return (TRUE, FALSE);                       // Exception level is using AArch64
    elsif secure && el == EL2 then
        return (TRUE, FALSE);                       // Secure EL2 is using AArch64
    elsif HighestELUsingAArch32() then
        return (TRUE, TRUE);                        // Highest Exception level, and therefore all levels a
    elsif el == HighestEL() then
        return (TRUE, FALSE);                       // This is highest Exception level, so is using AArch6

    // Remainder of function deals with the interprocessing cases when highest Exception level is using A

    boolean aarch32 = boolean UNKNOWN;
    boolean known = TRUE;

    aarch32_below_el3 = HaveEL(EL3) && SCR_EL3.RW == '0' && (!secure || !HaveSecureEL2Ext() || SCR_EL3.EE
    aarch32_at_el1 = (aarch32_below_el3 || (HaveEL(EL2) &&
                                            ((HaveSecureEL2Ext() && SCR_EL3.EEL2 == '1') || !secure) && H
                                            !(HCR_EL2.E2H == '1' && HCR_EL2.TGE == '1' && HaveVirtHostExt
    if el == EL0 && !aarch32_at_el1 then        // Only know if EL0 using AArch32 from PSTATE
        if PSTATE.EL == EL0 then
            aarch32 = PSTATE.nRW == '1';        // EL0 controlled by PSTATE
        else
            known = FALSE;                      // EL0 state is UNKNOWN
    else
        aarch32 = (aarch32_below_el3 && el != EL3) || (aarch32_at_el1 && el IN {EL1,EL0});

    if !known then aarch32 = boolean UNKNOWN;
    return (known, aarch32);
```

Library pseudocode for shared/functions/system/ELUsingAArch32

```
// ELUsingAArch32()
// ================

boolean ELUsingAArch32(bits(2) el)
    return ELStateUsingAArch32(el, IsSecureBelowEL3());
```

Library pseudocode for shared/functions/system/ELUsingAArch32K

```
// ELUsingAArch32K()
// =================

(boolean,boolean) ELUsingAArch32K(bits(2) el)
    return ELStateUsingAArch32K(el, IsSecureBelowEL3());
```

Library pseudocode for shared/functions/system/EndOfInstruction

```
// Terminate processing of the current instruction.
EndOfInstruction();
```

Library pseudocode for shared/functions/system/EnterLowPowerState

```
// PE enters a low-power state
EnterLowPowerState();
```

Library pseudocode for shared/functions/system/EventRegister

```
bits(1) EventRegister;
```

Library pseudocode for shared/functions/system/GetPSRFromPSTATE

```
// GetPSRFromPSTATE()
// ==================
// Return a PSR value which represents the current PSTATE

bits(32) GetPSRFromPSTATE()
    bits(32) spsr = Zeros();
    spsr<31:28> = PSTATE.<N,Z,C,V>;
    if HavePANExt() then spsr<22> = PSTATE.PAN;
    spsr<20>    = PSTATE.IL;
    if PSTATE.nRW == '1' then // AArch32 state
        spsr<27>    = PSTATE.Q;
        spsr<26:25> = PSTATE.IT<1:0>;
        if HaveSSBSExt() then spsr<23> = PSTATE.SSBS;
        if HaveDITExt() then spsr<21> = PSTATE.DIT;
        spsr<19:16> = PSTATE.GE;
        spsr<15:10> = PSTATE.IT<7:2>;
        spsr<9>     = PSTATE.E;
        spsr<8:6>   = PSTATE.<A,I,F>;                   // No PSTATE.D in AArch32 state
        spsr<5>     = PSTATE.T;
        assert PSTATE.M<4> == PSTATE.nRW;               // bit [4] is the discriminator
        spsr<4:0>   = PSTATE.M;
    else // AArch64 state
        if HaveMTEExt() then spsr<25> = PSTATE.TCO;
        if HaveDITExt() then spsr<24> = PSTATE.DIT;
        if HaveUAOExt() then spsr<23> = PSTATE.UAO;
        spsr<21>    = PSTATE.SS;
        if HaveSSBSExt() then spsr<12> = PSTATE.SSBS;
        if HaveBTIExt() then spsr<11:10> = PSTATE.BTYPE;
        spsr<9:6>   = PSTATE.<D,A,I,F>;
        spsr<4>     = PSTATE.nRW;
        spsr<3:2>   = PSTATE.EL;
        spsr<0>     = PSTATE.SP;
    return spsr;
```

Library pseudocode for shared/functions/system/HasArchVersion

```
// HasArchVersion()
// ================
// Return TRUE if the implemented architecture includes the extensions defined in the specified
// architecture version.

boolean HasArchVersion(ArchVersion version)
    return version == ARMv8p0 || boolean IMPLEMENTATION_DEFINED;
```

Library pseudocode for shared/functions/system/HaveAArch32EL

```
// HaveAArch32EL()
// ===============

boolean HaveAArch32EL(bits(2) el)
    // Return TRUE if Exception level 'el' supports AArch32 in this implementation
    if !HaveEL(el) then
        return FALSE;                     // The Exception level is not implemented
    elsif !HaveAnyAArch32() then
        return FALSE;                     // No Exception level can use AArch32
    elsif HighestELUsingAArch32() then
        return TRUE;                      // All Exception levels are using AArch32
    elsif el == HighestEL() then
        return FALSE;                     // The highest Exception level is using AArch64
    elsif el == EL0 then
        return TRUE;                      // EL0 must support using AArch32 if any AArch32
    return boolean IMPLEMENTATION_DEFINED;
```

Library pseudocode for shared/functions/system/HaveAnyAArch32

```
// HaveAnyAArch32()
// ================
// Return TRUE if AArch32 state is supported at any Exception level

boolean HaveAnyAArch32()
    return boolean IMPLEMENTATION_DEFINED;
```

Library pseudocode for shared/functions/system/HaveAnyAArch64

```
// HaveAnyAArch64()
// ================
// Return TRUE if AArch64 state is supported at any Exception level

boolean HaveAnyAArch64()
    return !HighestELUsingAArch32();
```

Library pseudocode for shared/functions/system/HaveEL

```
// HaveEL()
// ========
// Return TRUE if Exception level 'el' is supported

boolean HaveEL(bits(2) el)
    if el IN {EL1,EL0} then
        return TRUE;                            // EL1 and EL0 must exist
    return boolean IMPLEMENTATION_DEFINED;
```

Library pseudocode for shared/functions/system/HaveELUsingSecurityState

```
// HaveELUsingSecurityState()
// ==========================
// Returns TRUE if Exception level 'el' with Security state 'secure' is supported,
// FALSE otherwise.

boolean HaveELUsingSecurityState(bits(2) el, boolean secure)

    case el of
        when EL3
            assert secure;
            return HaveEL(EL3);
        when EL2
            if secure then
                return HaveEL(EL2) && HaveSecureEL2Ext();
            else
                return HaveEL(EL2);
        otherwise
            return (HaveEL(EL3) ||
                    (secure == boolean IMPLEMENTATION_DEFINED "Secure-only implementation"));
```

Library pseudocode for shared/functions/system/HaveFP16Ext

```
// HaveFP16Ext()
// =============
// Return TRUE if FP16 extension is supported

boolean HaveFP16Ext()
    return boolean IMPLEMENTATION_DEFINED;
```

Library pseudocode for shared/functions/system/HighestEL

```
// HighestEL()
// ===========
// Returns the highest implemented Exception level.

bits(2) HighestEL()
    if HaveEL(EL3) then
        return EL3;
    elsif HaveEL(EL2) then
        return EL2;
    else
        return EL1;
```

Library pseudocode for shared/functions/system/HighestELUsingAArch32

```
// HighestELUsingAArch32()
// =======================
// Return TRUE if configured to boot into AArch32 operation

boolean HighestELUsingAArch32()
    if !HaveAnyAArch32() then return FALSE;
    return boolean IMPLEMENTATION_DEFINED;       // e.g. CFG32SIGNAL == HIGH
```

Library pseudocode for shared/functions/system/Hint_Yield

```
Hint_Yield();
```

Library pseudocode for shared/functions/system/IllegalExceptionReturn

```
// IllegalExceptionReturn()
// ========================

boolean IllegalExceptionReturn(bits(32) spsr)

    // Check for illegal return:
    //   * To an unimplemented Exception level.
    //   * To EL2 in Secure state, when SecureEL2 is not enabled.
    //   * To EL0 using AArch64 state, with SPSR.M[0]==1.
    //   * To AArch64 state with SPSR.M[1]==1.
    //   * To AArch32 state with an illegal value of SPSR.M.
    (valid, target) = ELFromSPSR(spsr);
    if !valid then return TRUE;

    // Check for return to higher Exception level
    if UInt(target) > UInt(PSTATE.EL) then return TRUE;

    spsr_mode_is_aarch32 = (spsr<4> == '1');

    // Check for illegal return:
    //   * To EL1, EL2 or EL3 with register width specified in the SPSR different from the
    //     Execution state used in the Exception level being returned to, as determined by
    //     the SCR_EL3.RW or HCR_EL2.RW bits, or as configured from reset.
    //   * To EL0 using AArch64 state when EL1 is using AArch32 state as determined by the
    //     SCR_EL3.RW or HCR_EL2.RW bits or as configured from reset.
    //   * To AArch64 state from AArch32 state (should be caught by above)
    (known, target_el_is_aarch32) = ELUsingAArch32K(target);
    assert known || (target == EL0 && !ELUsingAArch32(EL1));
    if known && spsr_mode_is_aarch32 != target_el_is_aarch32 then return TRUE;

    // Check for illegal return from AArch32 to AArch64
    if UsingAArch32() && !spsr_mode_is_aarch32 then return TRUE;

    // Check for illegal return to EL1 when HCR.TGE is set and when either of
    // * SecureEL2 is enabled.
    // * SecureEL2 is not enabled and EL1 is in Non-secure state.
    if HaveEL(EL2) && target == EL1 && HCR_EL2.TGE == '1' then
        if (!IsSecureBelowEL3() || IsSecureEL2Enabled()) then return TRUE;
    return FALSE;
```

Library pseudocode for shared/functions/system/InstrSet

```
enumeration InstrSet {InstrSet_A64, InstrSet_A32, InstrSet_T32};
```

Library pseudocode for shared/functions/system/InstructionSynchronizationBarrier

```
InstructionSynchronizationBarrier();
```

Library pseudocode for shared/functions/system/InterruptPending

```
// InterruptPending()
// ==================
// Return TRUE if there are any pending physical or virtual interrupts, and FALSE otherwise

boolean InterruptPending()
    return IsPhysicalSErrorPending() || IsVirtualSErrorPending();
```

Library pseudocode for shared/functions/system/IsEventRegisterSet

```
// IsEventRegisterSet()
// ====================
// Return TRUE if the Event Register of this PE is set, and FALSE otherwise

boolean IsEventRegisterSet()
    return EventRegister == '1';
```

Library pseudocode for shared/functions/system/IsHighestEL

```
// IsHighestEL()
// =============
// Returns TRUE if given exception level is the highest exception level implemented

boolean IsHighestEL(bits(2) el)
    return HighestEL() == el;
```

Library pseudocode for shared/functions/system/IsInHost

```
// IsInHost()
// ==========

boolean IsInHost()
    return ELIsInHost(PSTATE.EL);
```

Library pseudocode for shared/functions/system/IsPhysicalSErrorPending

```
// Return TRUE if a physical SError interrupt is pending
boolean IsPhysicalSErrorPending();
```

Library pseudocode for shared/functions/system/IsSecure

```
// IsSecure()
// ==========
// Returns TRUE if current Exception level is in Secure state.

boolean IsSecure()
    if HaveEL(EL3) && !UsingAArch32() && PSTATE.EL == EL3 then
        return TRUE;
    elsif HaveEL(EL3) && UsingAArch32() && PSTATE.M == M32_Monitor then
        return TRUE;
    return IsSecureBelowEL3();
```

Library pseudocode for shared/functions/system/IsSecureBelowEL3

```
// IsSecureBelowEL3()
// ==================
// Return TRUE if an Exception level below EL3 is in Secure state
// or would be following an exception return to that level.
//
// Differs from IsSecure in that it ignores the current EL or Mode
// in considering security state.
// That is, if at AArch64 EL3 or in AArch32 Monitor mode, whether an
// exception return would pass to Secure or Non-secure state.

boolean IsSecureBelowEL3()
    if HaveEL(EL3) then
        return SCR_GEN[].NS == '0';
    elsif HaveEL(EL2) && (!HaveSecureEL2Ext() || HighestELUsingAArch32()) then
        // If Secure EL2 is not an architecture option then we must be Non-secure.
        return FALSE;
    else
        // TRUE if processor is Secure or FALSE if Non-secure.
        return boolean IMPLEMENTATION_DEFINED "Secure-only implementation";
```

Library pseudocode for shared/functions/system/IsSecureEL2Enabled

```
// IsSecureEL2Enabled()
// ====================
// Returns TRUE if Secure EL2 is enabled, FALSE otherwise.

boolean IsSecureEL2Enabled()
    if HaveEL(EL2) && HaveSecureEL2Ext() then
        if HaveEL(EL3) then
            if !ELUsingAArch32(EL3) && SCR_EL3.EEL2 == '1' then
                return TRUE;
            else
                return FALSE;
        else
            return IsSecure();
    else
        return FALSE;
```

Library pseudocode for shared/functions/system/IsVirtualSErrorPending

```
// Return TRUE if a virtual SError interrupt is pending
boolean IsVirtualSErrorPending();
```

Library pseudocode for shared/functions/system/Mode_Bits

```
constant bits(5) M32_User    = '10000';
constant bits(5) M32_FIQ     = '10001';
constant bits(5) M32_IRQ     = '10010';
constant bits(5) M32_Svc     = '10011';
constant bits(5) M32_Monitor = '10110';
constant bits(5) M32_Abort   = '10111';
constant bits(5) M32_Hyp     = '11010';
constant bits(5) M32_Undef   = '11011';
constant bits(5) M32_System  = '11111';
```

Library pseudocode for shared/functions/system/PLOfEL

```
// PLOfEL()
// ========

PrivilegeLevel PLOfEL(bits(2) el)
    case el of
        when EL3  return if HighestELUsingAArch32() then PL1 else PL3;
        when EL2  return PL2;
        when EL1  return PL1;
        when EL0  return PL0;
```

Library pseudocode for shared/functions/system/PSTATE

```
ProcState PSTATE;
```

Library pseudocode for shared/functions/system/PrivilegeLevel

```
enumeration PrivilegeLevel {PL3, PL2, PL1, PL0};
```

Library pseudocode for shared/functions/system/ProcState

```
type ProcState is (
    bits (1) N,        // Negative condition flag
    bits (1) Z,        // Zero condition flag
    bits (1) C,        // Carry condition flag
    bits (1) V,        // oVerflow condition flag
    bits (1) D,        // Debug mask bit                      [AArch64 only]
    bits (1) A,        // SError interrupt mask bit
    bits (1) I,        // IRQ mask bit
    bits (1) F,        // FIQ mask bit
    bits (1) PAN,      // Privileged Access Never Bit         [v8.1]
    bits (1) UAO,      // User Access Override                 [v8.2]
    bits (1) DIT,      // Data Independent Timing             [v8.4]
    bits (1) TCO,      // Tag Check Override                  [v8.5, AArch64 only]
    bits (2) BTYPE,    // Branch Type                         [v8.5]
    bits (1) SS,       // Software step bit
    bits (1) IL,       // Illegal Execution state bit
    bits (2) EL,       // Exception Level
    bits (1) nRW,      // not Register Width: 0=64, 1=32
    bits (1) SP,       // Stack pointer select: 0=SP0, 1=SPx [AArch64 only]
    bits (1) Q,        // Cumulative saturation flag          [AArch32 only]
    bits (4) GE,       // Greater than or Equal flags         [AArch32 only]
    bits (1) SSBS,     // Speculative Store Bypass Safe
    bits (8) IT,       // If-then bits, RES0 in CPSR          [AArch32 only]
    bits (1) J,        // J bit, RES0                         [AArch32 only, RES0 in SPSR and CPSR]
    bits (1) T,        // T32 bit, RES0 in CPSR               [AArch32 only]
    bits (1) E,        // Endianness bit                      [AArch32 only]
    bits (5) M         // Mode field                          [AArch32 only]
)
```

Library pseudocode for shared/functions/system/RestoredITBits

```
// RestoredITBits()
// ================
// Get the value of PSTATE.IT to be restored on this exception return.

bits(8) RestoredITBits(bits(32) spsr)
    it = spsr<15:10,26:25>;

    // When PSTATE.IL is set, it is CONSTRAINED UNPREDICTABLE whether the IT bits are each set
    // to zero or copied from the SPSR.
    if PSTATE.IL == '1' then
        if ConstrainUnpredictableBool(Unpredictable_ILZEROIT) then return '00000000';
        else return it;

    // The IT bits are forced to zero when they are set to a reserved value.
    if !IsZero(it<7:4>) && IsZero(it<3:0>) then
        return '00000000';

    // The IT bits are forced to zero when returning to A32 state, or when returning to an EL
    // with the ITD bit set to 1, and the IT bits are describing a multi-instruction block.
    itd = if PSTATE.EL == EL2 then HSCTLR.ITD else SCTLR.ITD;
    if (spsr<5> == '0' && !IsZero(it)) || (itd == '1' && !IsZero(it<2:0>)) then
        return '00000000';
    else
        return it;
```

Library pseudocode for shared/functions/system/SCRType

```
type SCRType;
```

Library pseudocode for shared/functions/system/SCR_GEN

```
// SCR_GEN[]
// =========

SCRType SCR_GEN[]
    // AArch32 secure & AArch64 EL3 registers are not architecturally mapped
    assert HaveEL(EL3);
    bits(64) r;
    if HighestELUsingAArch32() then
        r = ZeroExtend(SCR);
    else
        r = SCR_EL3;
    return r;
```

Library pseudocode for shared/functions/system/SendEvent

```
// Signal an event to all PEs in a multiprocessor system to set their Event Registers.
// When a PE executes the SEV instruction, it causes this function to be executed
SendEvent();
```

Library pseudocode for shared/functions/system/SendEventLocal

```
// SendEventLocal()
// ================
// Set the local Event Register of this PE.
// When a PE executes the SEVL instruction, it causes this function to be executed

SendEventLocal()
    EventRegister = '1';
    return;
```

Library pseudocode for shared/functions/system/SetPSTATEFromPSR

```
// SetPSTATEFromPSR()
// ==================
// Set PSTATE based on a PSR value

SetPSTATEFromPSR(bits(32) spsr)
    PSTATE.SS = DebugExceptionReturnSS(spsr);
    if IllegalExceptionReturn(spsr) then
        PSTATE.IL = '1';
        if HaveSSBSExt() then PSTATE.SSBS = bit UNKNOWN;
    else
        // State that is reinstated only on a legal exception return
        PSTATE.IL = spsr<20>;
        if spsr<4> == '1' then                    // AArch32 state
            AArch32.WriteMode(spsr<4:0>);         // Sets PSTATE.EL correctly
            if HaveSSBSExt() then PSTATE.SSBS = spsr<23>;
        else                                      // AArch64 state
            PSTATE.nRW = '0';
            PSTATE.EL  = spsr<3:2>;
            PSTATE.SP  = spsr<0>;
            if HaveSSBSExt() then PSTATE.SSBS = spsr<12>;

    // If PSTATE.IL is set and returning to AArch32 state, it is CONSTRAINED UNPREDICTABLE whether
    // the T bit is set to zero or copied from SPSR.
    if PSTATE.IL == '1' && PSTATE.nRW == '1' then
        if ConstrainUnpredictableBool(Unpredictable_ILZEROT) then spsr<5> = '0';

    // State that is reinstated regardless of illegal exception return
    PSTATE.<N,Z,C,V> = spsr<31:28>;
    if HavePANExt() then PSTATE.PAN = spsr<22>;
    if PSTATE.nRW == '1' then                     // AArch32 state
        PSTATE.Q         = spsr<27>;
        PSTATE.IT        = RestoredITBits(spsr);
        ShouldAdvanceIT  = FALSE;
        if HaveDITExt() then PSTATE.DIT = (if Restarting() then spsr<24> else spsr<21>);
        PSTATE.GE        = spsr<19:16>;
        PSTATE.E         = spsr<9>;
        PSTATE.<A,I,F>   = spsr<8:6>;             // No PSTATE.D in AArch32 state
        PSTATE.T         = spsr<5>;               // PSTATE.J is RES0
    else                                          // AArch64 state
        if HaveMTEExt() then PSTATE.TCO = spsr<25>;
        if HaveDITExt() then PSTATE.DIT = spsr<24>;
        if HaveUAOExt() then PSTATE.UAO = spsr<23>;
        if HaveBTIExt() then PSTATE.BTYPE = spsr<11:10>;
        PSTATE.<D,A,I,F> = spsr<9:6>;             // No PSTATE.<Q,IT,GE,E,T> in AArch64 state
    return;
```

Library pseudocode for shared/functions/system/ShouldAdvanceIT

```
boolean ShouldAdvanceIT;
```

Library pseudocode for shared/functions/system/SpeculationBarrier

```
SpeculationBarrier();
```

Library pseudocode for shared/functions/system/SynchronizeContext

```
SynchronizeContext();
```

Library pseudocode for shared/functions/system/SynchronizeErrors

```
// Implements the error synchronization event.
SynchronizeErrors();
```

Library pseudocode for shared/functions/system/TakeUnmaskedPhysicalSErrorInterrupts

```
// Take any pending unmasked physical SError interrupt
TakeUnmaskedPhysicalSErrorInterrupts(boolean iesb_req);
```

Library pseudocode for shared/functions/system/TakeUnmaskedSErrorInterrupts

```
// Take any pending unmasked physical SError interrupt or unmasked virtual SError
// interrupt.
TakeUnmaskedSErrorInterrupts();
```

Library pseudocode for shared/functions/system/ThisInstr

```
bits(32) ThisInstr();
```

Library pseudocode for shared/functions/system/ThisInstrLength

```
integer ThisInstrLength();
```

Library pseudocode for shared/functions/system/Unreachable

```
Unreachable()
    assert FALSE;
```

Library pseudocode for shared/functions/system/UsingAArch32

```
// UsingAArch32()
// ==============
// Return TRUE if the current Exception level is using AArch32, FALSE if using AArch64.

boolean UsingAArch32()
    boolean aarch32 = (PSTATE.nRW == '1');
    if !HaveAnyAArch32() then assert !aarch32;
    if HighestELUsingAArch32() then assert aarch32;
    return aarch32;
```

Library pseudocode for shared/functions/system/WaitForEvent

```
// WaitForEvent()
// ==============
// PE suspends its operation and enters a low-power state
// if the Event Register is clear when the WFE is executed

WaitForEvent()
    if EventRegister == '0' then
        EnterLowPowerState();
    return;
```

Library pseudocode for shared/functions/system/WaitForInterrupt

```
// WaitForInterrupt()
// ==================
// PE suspends its operation to enter a low-power state
// until a WFI wake-up event occurs or the PE is reset

WaitForInterrupt()
    EnterLowPowerState();
    return;
```

Library pseudocode for shared/functions/unpredictable/ConstrainUnpredictable

```
// ConstrainUnpredictable()
// ========================
// Return the appropriate Constraint result to control the caller's behavior. The return value
// is IMPLEMENTATION DEFINED within a permitted list for each UNPREDICTABLE case.
// (The permitted list is determined by an assert or case statement at the call site.)

// NOTE: This version of the function uses an Unpredictable argument to define the call site.
// This argument does not appear in the version used in the Armv8 Architecture Reference Manual.
// The extra argument is used here to allow this example definition. This is an example only and
// does not imply a fixed implementation of these behaviors. Indeed the intention is that it should
// be defined by each implementation, according to its implementation choices.

Constraint ConstrainUnpredictable(Unpredictable which)
    case which of
        when Unpredictable_WBOVERLAPLD
            return Constraint_WBSUPPRESS; // return loaded value
        when Unpredictable_WBOVERLAPST
            return Constraint_NONE;     // store pre-writeback value
        when Unpredictable_LDPOVERLAP
            return Constraint_UNDEF;    // instruction is UNDEFINED
        when Unpredictable_BASEOVERLAP
            return Constraint_NONE;     // use original address
        when Unpredictable_DATAOVERLAP
            return Constraint_NONE;     // store original value
        when Unpredictable_DEVPAGE2
            return Constraint_FAULT;    // take an alignment fault
        when Unpredictable_INSTRDEVICE
            return Constraint_NONE;     // Do not take a fault
        when Unpredictable_RESCPACR
            return Constraint_UNKNOWN;  // Map to UNKNOWN value
        when Unpredictable_RESMAIR
            return Constraint_UNKNOWN;  // Map to UNKNOWN value
        when Unpredictable_RESTEXCB
            return Constraint_UNKNOWN;  // Map to UNKNOWN value
        when Unpredictable_RESDACR
            return Constraint_UNKNOWN;  // Map to UNKNOWN value
        when Unpredictable_RESPRRR
            return Constraint_UNKNOWN;  // Map to UNKNOWN value
        when Unpredictable_RESVTCRS
            return Constraint_UNKNOWN;  // Map to UNKNOWN value
        when Unpredictable_RESTnSZ
            return Constraint_FORCE;    // Map to the limit value
        when Unpredictable_OORTnSZ
            return Constraint_FORCE;    // Map to the limit value
        when Unpredictable_LARGEIPA
            return Constraint_FORCE;    // Restrict the inputsize to the PAMax value
        when Unpredictable_ESRCONDPASS
            return Constraint_FALSE;    // Report as "AL"
        when Unpredictable_ILZEROIT
            return Constraint_FALSE;    // Do not zero PSTATE.IT
        when Unpredictable_ILZEROT
            return Constraint_FALSE;    // Do not zero PSTATE.T
        when Unpredictable_BPVECTORCATCHPRI
            return Constraint_TRUE;     // Debug Vector Catch: match on 2nd halfword
        when Unpredictable_VCMATCHHALF
            return Constraint_FALSE;    // No match
        when Unpredictable_VCMATCHDAPA
            return Constraint_FALSE;    // No match on Data Abort or Prefetch abort
        when Unpredictable_WPMASKANDBAS
            return Constraint_FALSE;    // Watchpoint disabled
        when Unpredictable_WPBASCONTIGUOUS
            return Constraint_FALSE;    // Watchpoint disabled
        when Unpredictable_RESWPMASK
            return Constraint_DISABLED; // Watchpoint disabled
        when Unpredictable_WPMASKEDBITS
            return Constraint_FALSE;    // Watchpoint disabled
        when Unpredictable_RESBPWPCTRL
            return Constraint_DISABLED; // Breakpoint/watchpoint disabled
        when Unpredictable_BPNOTIMPL
            return Constraint_DISABLED; // Breakpoint disabled
```

```
        when Unpredictable_RESBPTYPE
            return Constraint_DISABLED; // Breakpoint disabled
        when Unpredictable_BPNOTCTXCMP
            return Constraint_DISABLED; // Breakpoint disabled
        when Unpredictable_BPMATCHHALF
            return Constraint_FALSE;    // No match
        when Unpredictable_BPMISMATCHHALF
            return Constraint_FALSE;    // No match
        when Unpredictable_RESTARTALIGNPC
            return Constraint_FALSE;    // Do not force alignment
        when Unpredictable_RESTARTZEROUPPERPC
            return Constraint_TRUE;     // Force zero extension
        when Unpredictable_ZEROUPPER
            return Constraint_TRUE;     // zero top halves of X registers
        when Unpredictable_ERETZEROUPPERPC
            return Constraint_TRUE;     // zero top half of PC
        when Unpredictable_A32FORCEALIGNPC
            return Constraint_FALSE;    // Do not force alignment
        when Unpredictable_SMD
            return Constraint_UNDEF;    // disabled SMC is Unallocated
        when Unpredictable_NONFAULT
            return Constraint_FALSE;    // Speculation enabled
        when Unpredictable_SVEZEROUPPER
            return Constraint_TRUE;     // zero top bits of Z registers
        when Unpredictable_SVELDNFDATA
            return Constraint_TRUE;     // Load mem data in NF loads
        when Unpredictable_SVELDNFZERO
            return Constraint_TRUE;     // Write zeros in NF loads
        when Unpredictable_AFUPDATE     // AF update for alignment or permission fault
            return Constraint_TRUE;
        when Unpredictable_IESBinDebug  // Use SCTLR[].IESB in Debug state
            return Constraint_TRUE;
        when Unpredictable_ZEROBTYPE
            return Constraint_TRUE;    // Save BTYPE in SPSR_ELx/DPSR_EL0 as '00'
        when Unpredictable_CLEARERRITEZERO // Clearing sticky errors when instruction in flight
            return Constraint_FALSE;
```

Library pseudocode for shared/functions/unpredictable/ConstrainUnpredictableBits

```
// ConstrainUnpredictableBits()
// ============================

// This is a variant of ConstrainUnpredictable for when the result can be Constraint_UNKNOWN.
// If the result is Constraint_UNKNOWN then the function also returns UNKNOWN value, but that
// value is always an allocated value; that is, one for which the behavior is not itself
// CONSTRAINED.

// NOTE: This version of the function uses an Unpredictable argument to define the call site.
// This argument does not appear in the version used in the Armv8 Architecture Reference Manual.
// See the NOTE on ConstrainUnpredictable() for more information.

// This is an example placeholder only and does not imply a fixed implementation of the bits part
// of the result, and may not be applicable in all cases.

(Constraint,bits(width)) ConstrainUnpredictableBits(Unpredictable which)

    c = ConstrainUnpredictable(which);

    if c == Constraint_UNKNOWN then
        return (c, Zeros(width));           // See notes; this is an example implementation only
    else
        return (c, bits(width) UNKNOWN);    // bits result not used
```

Library pseudocode for shared/functions/unpredictable/ConstrainUnpredictableBool

```
// ConstrainUnpredictableBool()
// ============================

// This is a simple wrapper function for cases where the constrained result is either TRUE or FALSE.

// NOTE: This version of the function uses an Unpredictable argument to define the call site.
// This argument does not appear in the version used in the Armv8 Architecture Reference Manual.
// See the NOTE on ConstrainUnpredictable() for more information.

boolean ConstrainUnpredictableBool(Unpredictable which)

    c = ConstrainUnpredictable(which);
    assert c IN {Constraint_TRUE, Constraint_FALSE};
    return (c == Constraint_TRUE);
```

Library pseudocode for shared/functions/unpredictable/ConstrainUnpredictableInteger

```
// ConstrainUnpredictableInteger()
// ===============================

// This is a variant of ConstrainUnpredictable for when the result can be Constraint_UNKNOWN. If
// the result is Constraint_UNKNOWN then the function also returns an UNKNOWN value in the range
// low to high, inclusive.

// NOTE: This version of the function uses an Unpredictable argument to define the call site.
// This argument does not appear in the version used in the Armv8 Architecture Reference Manual.
// See the NOTE on ConstrainUnpredictable() for more information.

// This is an example placeholder only and does not imply a fixed implementation of the integer part
// of the result.

(Constraint,integer) ConstrainUnpredictableInteger(integer low, integer high, Unpredictable which)

    c = ConstrainUnpredictable(which);

    if c == Constraint_UNKNOWN then
        return (c, low);                // See notes; this is an example implementation only
    else
        return (c, integer UNKNOWN);    // integer result not used
```

Library pseudocode for shared/functions/unpredictable/Constraint

```
enumeration Constraint    {// General
                           Constraint_NONE,              // Instruction executes with
                                                         //   no change or side-effect to its described b
                           Constraint_UNKNOWN,           // Destination register has UNKNOWN value
                           Constraint_UNDEF,             // Instruction is UNDEFINED
                           Constraint_UNDEFEL0,          // Instruction is UNDEFINED at EL0 only
                           Constraint_NOP,               // Instruction executes as NOP
                           Constraint_TRUE,
                           Constraint_FALSE,
                           Constraint_DISABLED,
                           Constraint_UNCOND,            // Instruction executes unconditionally
                           Constraint_COND,              // Instruction executes conditionally
                           Constraint_ADDITIONAL_DECODE, // Instruction executes with additional decode
                           // Load-store
                           Constraint_WBSUPPRESS, Constraint_FAULT,
                           // IPA too large
                           Constraint_FORCE, Constraint_FORCENOSLCHECK};
```

Library pseudocode for shared/functions/unpredictable/Unpredictable

```
enumeration Unpredictable {// Writeback/transfer register overlap (load)
                           Unpredictable_WBOVERLAPLD,
                           // Writeback/transfer register overlap (store)
                           Unpredictable_WBOVERLAPST,
                           // Load Pair transfer register overlap
                           Unpredictable_LDPOVERLAP,
                           // Store-exclusive base/status register overlap
                           Unpredictable_BASEOVERLAP,
                           // Store-exclusive data/status register overlap
                           Unpredictable_DATAOVERLAP,
                           // Load-store alignment checks
                           Unpredictable_DEVPAGE2,
                           // Instruction fetch from Device memory
                           Unpredictable_INSTRDEVICE,
                           // Reserved CPACR value
                           Unpredictable_RESCPACR,
                           // Reserved MAIR value
                           Unpredictable_RESMAIR,
                           // Reserved TEX:C:B value
                           Unpredictable_RESTEXCB,
                           // Reserved PRRR value
                           Unpredictable_RESPRRR,
                           // Reserved DACR field
                           Unpredictable_RESDACR,
                           // Reserved VTCR.S value
                           Unpredictable_RESVTCRS,
                           // Reserved TCR.TnSZ value
                           Unpredictable_RESTnSZ,
                           // Reserved SCTLR_ELx.TCF value                    // Out-of-range TCR.
                           Unpredictable_RESTCF,
                           // Out-of-range TCR.TnSZ valueUnpredictable_OORTnSZ,
                           // IPA size exceeds PA size
                           Unpredictable_OORTnSZ,
                           // IPA size exceeds PA sizeUnpredictable_LARGEIPA,
                           // Syndrome for a known-passing conditional A32 instruction
                           Unpredictable_LARGEIPA,
                           // Syndrome for a known-passing conditional A32 instructionUnpredictable_ESRCO
                           // Illegal State exception: zero PSTATE.IT
                           Unpredictable_ESRCONDPASS,
                           // Illegal State exception: zero PSTATE.ITUnpredictable_ILZEROIT,
                           // Illegal State exception: zero PSTATE.T
                           Unpredictable_ILZEROIT,
                           // Illegal State exception: zero PSTATE.TUnpredictable_ILZEROT,
                           // Debug: prioritization of Vector Catch
                           Unpredictable_ILZEROT,
                           // Debug: prioritization of Vector CatchUnpredictable_BPVECTORCATCHPRI,
                           // Debug Vector Catch: match on 2nd halfword
                           Unpredictable_BPVECTORCATCHPRI,
                           // Debug Vector Catch: match on 2nd halfwordUnpredictable_VCMATCHHALF,
                           // Debug Vector Catch: match on Data Abort or Prefetch abort
                           Unpredictable_VCMATCHHALF,
                           // Debug Vector Catch: match on Data Abort or Prefetch abortUnpredictable_VCMA
                           // Debug watchpoints: non-zero MASK and non-ones BAS
                           Unpredictable_VCMATCHDAPA,
                           // Debug watchpoints: non-zero MASK and non-ones BASUnpredictable_WPMASKANDBAS
                           // Debug watchpoints: non-contiguous BAS
                           Unpredictable_WPMASKANDBAS,
                           // Debug watchpoints: non-contiguous BASUnpredictable_WPBASCONTIGUOUS,
                           // Debug watchpoints: reserved MASK
                           Unpredictable_WPBASCONTIGUOUS,
                           // Debug watchpoints: reserved MASKUnpredictable_RESWPMASK,
                           // Debug watchpoints: non-zero MASKed bits of address
                           Unpredictable_RESWPMASK,
                           // Debug watchpoints: non-zero MASKed bits of addressUnpredictable_WPMASKEDBIT
                           // Debug breakpoints and watchpoints: reserved control bits
                           Unpredictable_WPMASKEDBITS,
                           // Debug breakpoints and watchpoints: reserved control bitsUnpredictable_RESBP
                           // Debug breakpoints: not implemented
                           Unpredictable_RESBPWPCTRL,
                           // Debug breakpoints: not implementedUnpredictable_BPNOTIMPL,
```

```
// Debug breakpoints: reserved type
Unpredictable_BPNOTIMPL,
// Debug breakpoints: reserved typeUnpredictable_RESBPTYPE,
// Debug breakpoints: not-context-aware breakpoint
Unpredictable_RESBPTYPE,
// Debug breakpoints: not-context-aware breakpointUnpredictable_BPNOTCTXCMP,
// Debug breakpoints: match on 2nd halfword of instruction
Unpredictable_BPNOTCTXCMP,
// Debug breakpoints: match on 2nd halfword of instructionUnpredictable_BPMATC
// Debug breakpoints: mismatch on 2nd halfword of instruction
Unpredictable_BPMATCHHALF,
// Debug breakpoints: mismatch on 2nd halfword of instructionUnpredictable_BPM
// Debug: restart to a misaligned AArch32 PC value
Unpredictable_BPMISMATCHHALF,
// Debug: restart to a misaligned AArch32 PC valueUnpredictable_RESTARTALIGNPC
// Debug: restart to a not-zero-extended AArch32 PC value
Unpredictable_RESTARTALIGNPC,
// Debug: restart to a not-zero-extended AArch32 PC valueUnpredictable_RESTART
// Zero top 32 bits of X registers in AArch32 state
Unpredictable_RESTARTZEROUPPERPC,
// Zero top 32 bits of X registers in AArch32 stateUnpredictable_ZEROUPPER,
// Zero top 32 bits of PC on illegal return to AArch32 state
Unpredictable_ZEROUPPER,
// Zero top 32 bits of PC on illegal return to AArch32 stateUnpredictable_ERET
// Force address to be aligned when interworking branch to A32 state
Unpredictable_ERETZEROUPPERPC,
// Force address to be aligned when interworking branch to A32 stateUnpredicta
// SMC disabled
Unpredictable_A32FORCEALIGNPC,
// SMC disabledUnpredictable_SMD,
// FF speculation
Unpredictable_SMD,
// FF speculationUnpredictable_NONFAULT,
// Zero top bits of Z registers in EL change
Unpredictable_NONFAULT,
// Zero top bits of Z registers in EL changeUnpredictable_SVEZEROUPPER,
// Load mem data in NF loads
Unpredictable_SVEZEROUPPER,
// Load mem data in NF loadsUnpredictable_SVELDNFDATA,
// Write zeros in NF loads
Unpredictable_SVELDNFDATA,
// Write zeros in NF loadsUnpredictable_SVELDNFZERO,
// Access Flag Update by HW
Unpredictable_SVELDNFZERO,
// Access Flag Update by HWUnpredictable_AFUPDATE,
// Consider SCTLR[].IESB in Debug state
Unpredictable_AFUPDATE,
// Consider SCTLR[].IESB in Debug stateUnpredictable_IESBinDebug,
// No events selected in PMSEVFR_EL1
Unpredictable_IESBinDebug,
// No events selected in PMSEVFR_EL1Unpredictable_ZEROPMSEVFR,
// No operation type selected in PMSFCR_EL1
Unpredictable_ZEROPMSEVFR,
// No operation type selected in PMSFCR_EL1Unpredictable_NOOPTYPES,
// Zero latency in PMSLATFR_EL1
Unpredictable_NOOPTYPES,
// Zero latency in PMSLATFR_EL1Unpredictable_ZEROMINLATENCY,
// Zero saved BType value in SPSR_ELx/DPSR_EL0
Unpredictable_ZEROMINLATENCY,
// Zero saved BType value in SPSR_ELx/DPSR_EL0Unpredictable_ZEROBTYPE,
// Timestamp constrained to virtual or physical
Unpredictable_ZEROBTYPE,
// Timestamp constrained to virtual or physicalUnpredictable_EL2TIMESTAMP,
Unpredictable_EL2TIMESTAMP,Unpredictable_EL1TIMESTAMP,
// Clearing DCC/ITR sticky flags when instruction is in flight
Unpredictable_EL1TIMESTAMP,
// Clearing DCC/ITR sticky flags when instruction is in flightUnpredictable_CL
Unpredictable_CLEARERRITEZERO};
```

Library pseudocode for shared/functions/vector/AdvSIMDExpandImm

```
// AdvSIMDExpandImm()
// ==================

bits(64) AdvSIMDExpandImm(bit op, bits(4) cmode, bits(8) imm8)
    case cmode<3:1> of
        when '000'
            imm64 = Replicate(Zeros(24):imm8, 2);
        when '001'
            imm64 = Replicate(Zeros(16):imm8:Zeros(8), 2);
        when '010'
            imm64 = Replicate(Zeros(8):imm8:Zeros(16), 2);
        when '011'
            imm64 = Replicate(imm8:Zeros(24), 2);
        when '100'
            imm64 = Replicate(Zeros(8):imm8, 4);
        when '101'
            imm64 = Replicate(imm8:Zeros(8), 4);
        when '110'
            if cmode<0> == '0' then
                imm64 = Replicate(Zeros(16):imm8:Ones(8), 2);
            else
                imm64 = Replicate(Zeros(8):imm8:Ones(16), 2);
        when '111'
            if cmode<0> == '0' && op == '0' then
                imm64 = Replicate(imm8, 8);
            if cmode<0> == '0' && op == '1' then
                imm8a = Replicate(imm8<7>, 8); imm8b = Replicate(imm8<6>, 8);
                imm8c = Replicate(imm8<5>, 8); imm8d = Replicate(imm8<4>, 8);
                imm8e = Replicate(imm8<3>, 8); imm8f = Replicate(imm8<2>, 8);
                imm8g = Replicate(imm8<1>, 8); imm8h = Replicate(imm8<0>, 8);
                imm64 = imm8a:imm8b:imm8c:imm8d:imm8e:imm8f:imm8g:imm8h;
            if cmode<0> == '1' && op == '0' then
                imm32 = imm8<7>:NOT(imm8<6>):Replicate(imm8<6>,5):imm8<5:0>:Zeros(19);
                imm64 = Replicate(imm32, 2);
            if cmode<0> == '1' && op == '1' then
                if UsingAArch32() then ReservedEncoding();
                imm64 = imm8<7>:NOT(imm8<6>):Replicate(imm8<6>,8):imm8<5:0>:Zeros(48);

    return imm64;
```

Library pseudocode for shared/functions/vector/PolynomialMult

```
// PolynomialMult()
// ================

bits(M+N) PolynomialMult(bits(M) op1, bits(N) op2)
    result = Zeros(M+N);
    extended_op2 = ZeroExtend(op2, M+N);
    for i=0 to M-1
        if op1<i> == '1' then
            result = result EOR LSL(extended_op2, i);
    return result;
```

Library pseudocode for shared/functions/vector/SatQ

```
// SatQ()
// ======

(bits(N), boolean) SatQ(integer i, integer N, boolean unsigned)
    (result, sat) = if unsigned then UnsignedSatQ(i, N) else SignedSatQ(i, N);
    return (result, sat);
```

Library pseudocode for shared/functions/vector/SignedSatQ

```
// SignedSatQ()
// ============

(bits(N), boolean) SignedSatQ(integer i, integer N)
    if i > 2^(N-1) - 1 then
        result = 2^(N-1) - 1;  saturated = TRUE;
    elsif i < -(2^(N-1)) then
        result = -(2^(N-1));  saturated = TRUE;
    else
        result = i;  saturated = FALSE;
    return (result<N-1:0>, saturated);
```

Library pseudocode for shared/functions/vector/UnsignedRSqrtEstimate

```
// UnsignedRSqrtEstimate()
// =======================

bits(N) UnsignedRSqrtEstimate(bits(N) operand)
    assert N IN {16,32};
    if operand<N-1:N-2> == '00' then  // Operands <= 0x3FFFFFFF produce 0xFFFFFFFF
        result = Ones(N);
    else
        // input is in the range 0x40000000 .. 0xffffffff representing [0.25 .. 1.0)

        // estimate is in the range 256 .. 511 representing [1.0 .. 2.0)
        case N of
            when 16 estimate = RecipSqrtEstimate(UInt(operand<15:7>));
            when 32 estimate = RecipSqrtEstimate(UInt(operand<31:23>));

        // result is in the range 0x80000000 .. 0xff800000 representing [1.0 .. 2.0)
        result = estimate<8:0> : Zeros(N-9);

    return result;
```

Library pseudocode for shared/functions/vector/UnsignedRecipEstimate

```
// UnsignedRecipEstimate()
// =======================

bits(N) UnsignedRecipEstimate(bits(N) operand)
    assert N IN {16,32};
    if operand<N-1> == '0' then  // Operands <= 0x7FFFFFFF produce 0xFFFFFFFF
        result = Ones(N);
    else
        // input is in the range 0x80000000 .. 0xffffffff representing [0.5 .. 1.0)

        // estimate is in the range 256 to 511 representing [1.0 .. 2.0)
        case N of
            when 16 estimate = RecipEstimate(UInt(operand<15:7>));
            when 32 estimate = RecipEstimate(UInt(operand<31:23>));

        // result is in the range 0x80000000 .. 0xff800000 representing [1.0 .. 2.0)
        result = estimate<8:0> : Zeros(N-9);

    return result;
```

Library pseudocode for shared/functions/vector/UnsignedSatQ

```
// UnsignedSatQ()
// ==============

(bits(N), boolean) UnsignedSatQ(integer i, integer N)
    if i > 2^N - 1 then
        result = 2^N - 1;  saturated = TRUE;
    elsif i < 0 then
        result = 0;  saturated = TRUE;
    else
        result = i;  saturated = FALSE;
    return (result<N-1:0>, saturated);
```

Library pseudocode for shared/trace/selfhosted/SelfHostedTraceEnabled

```
// SelfHostedTraceEnabled()
// ========================
// Returns TRUE if Self-hosted Trace is enabled.

boolean SelfHostedTraceEnabled()
    if !HaveTraceExt() || !HaveSelfHostedTrace() then return FALSE;
    if HaveEL(EL3) then
        secure_trace_enable = (if ELUsingAArch32(EL3) then SDCR.STE else MDCR_EL3.STE);
        niden = (secure_trace_enable == '0' || ExternalSecureNoninvasiveDebugEnabled());
    else
        // If no EL3, IsSecure() returns the Effective value of (SCR_EL3.NS == '0')
        niden = (!IsSecure() || ExternalSecureNoninvasiveDebugEnabled());
    return (EDSCR.TFO == '0' || !niden);
```

Library pseudocode for shared/trace/selfhosted/TraceAllowed

```
// TraceAllowed()
// ==============
// Returns TRUE if Self-hosted Trace is allowed in the current Security state and Exception Level

boolean TraceAllowed()
    if !HaveTraceExt() then return FALSE;
    if SelfHostedTraceEnabled() then
        if IsSecure() && HaveEL(EL3) then
            secure_trace_enable = (if ELUsingAArch32(EL3) then SDCR.STE else MDCR_EL3.STE);
            if secure_trace_enable == '0' then return FALSE;

        TGE_bit = if EL2Enabled() then HCR_EL2.TGE else '0';
        case PSTATE.EL of
            when EL3  TRE_bit = if HighestELUsingAArch32() then TRFCR.E1TRE else '0';
            when EL2  TRE_bit = TRFCR_EL2.E2TRE;
            when EL1  TRE_bit = TRFCR_EL1.E1TRE;
            when EL0  TRE_bit = if TGE_bit == '1' then TRFCR_EL2.E0HTRE else TRFCR_EL1.E0TRE;
        return TRE_bit == '1';
    else
        return (!IsSecure() || ExternalSecureNoninvasiveDebugEnabled());
```

Library pseudocode for shared/trace/selfhosted/TraceContextIDR2

```
// TraceContextIDR2()
// ==================

boolean TraceContextIDR2()
    if !TraceAllowed()|| !HaveEL(EL2) then return FALSE;
    return (!SelfHostedTraceEnabled() || TRFCR_EL2.CX == '1');
```

Library pseudocode for shared/trace/selfhosted/TraceSynchronizationBarrier

```
// Memory barrier instruction that preserves the relative order of memory accesses to System
// registers due to trace operations and other memory accesses to the same registers
TraceSynchronizationBarrier();
```

Library pseudocode for shared/trace/selfhosted/TraceTimeStamp

```
// TraceTimeStamp()
// ================

TimeStamp TraceTimeStamp()
    if SelfHostedTraceEnabled() then
        if HaveEL(EL2) then
            TS_el2 = TRFCR_EL2.TS;
            if TS_el2 == '10' then (-, TS_el2) = ConstrainUnpredictableBits(Unpredictable_EL2TIMESTAMP);
            case TS_el2 of
                when '00'  /* falls through to check TRFCR_EL1.TS */
                when '01'  return TimeStamp_Virtual;
                when '11'  return TimeStamp_Physical;
                otherwise  Unreachable();          // ConstrainUnpredictableBits removes this case
        TS_el1 = TRFCR_EL1.TS;
        if TS_el1 == 'x0' then (-, TS_el1) = ConstrainUnpredictableBits(Unpredictable_EL1TIMESTAMP);
        case TS_el1 of
            when '01'  return TimeStamp_Virtual;
            when '11'  return TimeStamp_Physical;
            otherwise  Unreachable();              // ConstrainUnpredictableBits removes this case
    else
        return TimeStamp_CoreSight;
```

Library pseudocode for shared/trace/system/IsTraceCorePowered

```
// Returns TRUE if the Trace Core Power Domain is powered up
boolean IsTraceCorePowered();
```

Library pseudocode for shared/translation/attrs/CombineS1S2AttrHints

```
// CombineS1S2AttrHints()
// ======================
// Combines cacheability attributes and allocation hints from stage 1 and stage 2

MemAttrHints CombineS1S2AttrHints(MemAttrHints s1desc, MemAttrHints s2desc)

    MemAttrHints result;

    apply_force_writeback = HaveStage2MemAttrControl() && HCR_EL2.FWB == '1';

    if apply_force_writeback then
        if s2desc.attrs == '11' then
            result.attrs = s1desc.attrs;
        elsif s2desc.attrs == '10' then
            result.attrs = MemAttr_WB;    // force Write-back
        else
            result.attrs = MemAttr_NC;
    else
        if s2desc.attrs == '01' || s1desc.attrs == '01' then
            result.attrs = bits(2) UNKNOWN;   // Reserved
        elsif s2desc.attrs == MemAttr_NC || s1desc.attrs == MemAttr_NC then
            result.attrs = MemAttr_NC;        // Non-cacheable
        elsif s2desc.attrs == MemAttr_WT || s1desc.attrs == MemAttr_WT then
            result.attrs = MemAttr_WT;        // Write-through
        else
            result.attrs = MemAttr_WB;        // Write-back

    if HaveStage2MemAttrControl() && HCR_EL2.FWB == '1' then
        if s1desc.attrs != MemAttr_NC && result.attrs != MemAttr_NC then
            result.hints = s1desc.hints;
        elsif s1desc.attrs == MemAttr_NC && result.attrs != MemAttr_NC then
            result.hints = MemHint_RWA;
    else
        result.hints = s1desc.hints;
    result.transient = s1desc.transient;

    return result;
```

Library pseudocode for shared/translation/attrs/CombineS1S2Desc

```
// CombineS1S2Desc()
// =================
// Combines the address descriptors from stage 1 and stage 2

AddressDescriptor CombineS1S2Desc(AddressDescriptor s1desc, AddressDescriptor s2desc)

    AddressDescriptor result;

    result.paddress = s2desc.paddress;

    apply_force_writeback = HaveStage2MemAttrControl() && HCR_EL2.FWB == '1';

    if IsFault(s1desc) || IsFault(s2desc) then
        result = if IsFault(s1desc) then s1desc else s2desc;
    else
        result.fault = NSPACE(NoFault)();
        if s2desc.mematttrs.memtype ==    elsif s2desc.mematttrs.memtype == MemType_Device || (
            (apply_force_writeback && s1desc.mematttrs.memtype == MemType_Device && s2desc.mematttrs.inner.
            (!apply_force_writeback && s1desc.mematttrs.memtype == MemType_Device) ) then
            result.mematttrs.memtype = MemType_Device;
            if s1desc.mematttrs.memtype == MemType_Normal then
                result.mematttrs.device = s2desc.mematttrs.device;
            elsif s2desc.mematttrs.memtype == MemType_Normal then
                result.mematttrs.device = s1desc.mematttrs.device;
            else                        // Both Device
                result.mematttrs.device = CombineS1S2Device(s1desc.mematttrs.device,
                                                            s2desc.mematttrs.device);
            result.mematttrs.tagged = FALSE;
        else
            result.mematttrs.memtype = MemType_Normal;
            result.mematttrs.device = DeviceType UNKNOWN;
            if apply_force_writeback then
                if s2desc.mematttrs.memtype == MemType_Normal && s2desc.mematttrs.inner.attrs == '10' then
                    result.mematttrs.inner.attrs = MemAttr_WB;    // force Write-back
                elsif s2desc.mematttrs.inner.attrs == '11' then
                    result.mematttrs.inner.attrs = s1desc.mematttrs.inner.attrs;
                else
                    result.mematttrs.inner.attrs = MemAttr_NC;
                result.mematttrs.outer = result.mematttrs.inner;
            else
                result.mematttrs.inner = CombineS1S2AttrHints(s1desc.mematttrs.inner, s2desc.mematttrs.inner
                result.mematttrs.outer = CombineS1S2AttrHints(s1desc.mematttrs.outer, s2desc.mematttrs.outer
            result.mematttrs.shareable = (s1desc.mematttrs.shareable || s2desc.mematttrs.shareable);
            result.mematttrs.outershareable = (s1desc.mematttrs.outershareable ||
                                               s2desc.mematttrs.outershareable);
            result.mematttrs.tagged = (s1desc.mematttrs.tagged &&
                                       result.mematttrs.inner.attrs == MemAttr_WB &&
                                       result.mematttrs.inner.hints == MemHint_RWA &&
                                       result.mematttrs.outer.attrs == MemAttr_WB &&
                                       result.mematttrs.outer.hints == MemHint_RWA);

    result.mematttrs = MemAttrDefaults(result.mematttrs);

    return result;
```

Library pseudocode for shared/translation/attrs/CombineS1S2Device

```
// CombineS1S2Device()
// ==================
// Combines device types from stage 1 and stage 2

DeviceType CombineS1S2Device(DeviceType s1device, DeviceType s2device)

    if s2device == DeviceType_nGnRnE || s1device == DeviceType_nGnRnE then
        result = DeviceType_nGnRnE;
    elsif s2device == DeviceType_nGnRE || s1device == DeviceType_nGnRE then
        result = DeviceType_nGnRE;
    elsif s2device == DeviceType_nGRE || s1device == DeviceType_nGRE then
        result = DeviceType_nGRE;
    else
        result = DeviceType_GRE;

    return result;
```

Library pseudocode for shared/translation/attrs/LongConvertAttrsHints

```
// LongConvertAttrsHints()
// =======================
// Convert the long attribute fields for Normal memory as used in the MAIR fields
// to orthogonal attributes and hints

MemAttrHints LongConvertAttrsHints(bits(4) attrfield, AccType acctype)
    assert !IsZero(attrfield);
    MemAttrHints result;
    if S1CacheDisabled(acctype) then             // Force Non-cacheable
        result.attrs = MemAttr_NC;
        result.hints = MemHint_No;
    else
        if attrfield<3:2> == '00' then          // Write-through transient
            result.attrs = MemAttr_WT;
            result.hints = attrfield<1:0>;
            result.transient = TRUE;
        elsif attrfield<3:0> == '0100' then     // Non-cacheable (no allocate)
            result.attrs = MemAttr_NC;
            result.hints = MemHint_No;
            result.transient = FALSE;
        elsif attrfield<3:2> == '01' then       // Write-back transient
            result.attrs = MemAttr_WB;
            result.hints = attrfield<1:0>;
            result.transient = TRUE;
        else                                    // Write-through/Write-back non-transient
            result.attrs = attrfield<3:2>;
            result.hints = attrfield<1:0>;
            result.transient = FALSE;

    return result;
```

Library pseudocode for shared/translation/attrs/MemAttrDefaults

```
// MemAttrDefaults()
// =================
// Supply default values for memory attributes, including overriding the shareability attributes
// for Device and Non-cacheable memory types.

MemoryAttributes MemAttrDefaults(MemoryAttributes memattrs)

    if memattrs.memtype == MemType_Device then
        memattrs.inner = MemAttrHints UNKNOWN;
        memattrs.outer = MemAttrHints UNKNOWN;
        memattrs.shareable = TRUE;
        memattrs.outershareable = TRUE;
    else
        memattrs.device = DeviceType UNKNOWN;
        if memattrs.inner.attrs == MemAttr_NC && memattrs.outer.attrs == MemAttr_NC then
            memattrs.shareable = TRUE;
            memattrs.outershareable = TRUE;

    return memattrs;
```

Library pseudocode for shared/translation/attrs/S1CacheDisabled

```
// S1CacheDisabled()
// =================

boolean S1CacheDisabled(AccType acctype)
    if ELUsingAArch32(S1TranslationRegime()) then
        if PSTATE.EL == EL2 then
            enable = if acctype == AccType_IFETCH then HSCTLR.I else HSCTLR.C;
        else
            enable = if acctype == AccType_IFETCH then SCTLR.I else SCTLR.C;
    else
        enable = if acctype == AccType_IFETCH then SCTLR[].I else SCTLR[].C;
    return enable == '0';
```

Library pseudocode for shared/translation/attrs/S2AttrDecode

```
// S2AttrDecode()
// ==============
// Converts the Stage 2 attribute fields into orthogonal attributes and hints

MemoryAttributes S2AttrDecode(bits(2) SH, bits(4) attr, AccType acctype)

    MemoryAttributes memattrs;

    apply_force_writeback = HaveStage2MemAttrControl() && HCR_EL2.FWB == '1';

    // Device memory
    if (apply_force_writeback && attr<2> == '0') || attr<3:2> == '00' then
        memattrs.memtype = MemType_Device;
        case attr<1:0> of
            when '00'  memattrs.device = DeviceType_nGnRnE;
            when '01'  memattrs.device = DeviceType_nGnRE;
            when '10'  memattrs.device = DeviceType_nGRE;
            when '11'  memattrs.device = DeviceType_GRE;

    // Normal memory
    elsif apply_force_writeback then
        if attr<2> == '1' then
            memattrs.memtype = MemType_Normal;
            memattrs.inner.attrs = attr<1:0>;
            memattrs.outer.attrs = attr<1:0>;
    elsif attr<1:0> != '00' then
        memattrs.memtype = MemType_Normal;
        memattrs.outer = S2ConvertAttrsHints(attr<3:2>, acctype);
        memattrs.inner = S2ConvertAttrsHints(attr<1:0>, acctype);
        memattrs.shareable = SH<1> == '1';
        memattrs.outershareable = SH == '10';
    else
        memattrs = MemoryAttributes UNKNOWN;    // Reserved

    return MemAttrDefaults(memattrs);
```

Library pseudocode for shared/translation/attrs/S2CacheDisabled

```
// S2CacheDisabled()
// =================

boolean S2CacheDisabled(AccType acctype)
    if ELUsingAArch32(EL2) then
        disable = if acctype == AccType_IFETCH then HCR2.ID else HCR2.CD;
    else
        disable = if acctype == AccType_IFETCH then HCR_EL2.ID else HCR_EL2.CD;
    return disable == '1';
```

Library pseudocode for shared/translation/attrs/S2ConvertAttrsHints

```
// S2ConvertAttrsHints()
// =====================
// Converts the attribute fields for Normal memory as used in stage 2
// descriptors to orthogonal attributes and hints

MemAttrHints S2ConvertAttrsHints(bits(2) attr, AccType acctype)
    assert !IsZero(attr);

    MemAttrHints result;

    if HCR_EL2.FWB=='0' &&     if S2CacheDisabled(acctype) then               // Force Non-cacheable
        result.attrs = MemAttr_NC;
        result.hints = MemHint_No;
    else
        case attr of
            when '01'                                   // Non-cacheable (no allocate)
                result.attrs = MemAttr_NC;
                result.hints = MemHint_No;
            when '10'                                   // Write-through
                result.attrs = MemAttr_WT;
                result.hints = MemHint_RWA;
            when '11'                                   // Write-back
                result.attrs = MemAttr_WB;
                result.hints = MemHint_RWA;

    result.transient = FALSE;

    return result;
```

Library pseudocode for shared/translation/attrs/ShortConvertAttrsHints

```
// ShortConvertAttrsHints()
// ========================
// Converts the short attribute fields for Normal memory as used in the TTBR and
// TEX fields to orthogonal attributes and hints

MemAttrHints ShortConvertAttrsHints(bits(2) RGN, AccType acctype, boolean secondstage)

    MemAttrHints result;

    if (!secondstage && S1CacheDisabled(acctype)) || (secondstage && S2CacheDisabled(acctype)) then
       // Force Non-cacheable
        result.attrs = MemAttr_NC;
        result.hints = MemHint_No;
    else
        case RGN of
            when '00'                   // Non-cacheable (no allocate)
                result.attrs = MemAttr_NC;
                result.hints = MemHint_No;
            when '01'                   // Write-back, Read and Write allocate
                result.attrs = MemAttr_WB;
                result.hints = MemHint_RWA;
            when '10'                   // Write-through, Read allocate
                result.attrs = MemAttr_WT;
                result.hints = MemHint_RA;
            when '11'                   // Write-back, Read allocate
                result.attrs = MemAttr_WB;
                result.hints = MemHint_RA;

    result.transient = FALSE;

    return result;
```

Library pseudocode for shared/translation/attrs/WalkAttrDecode

```
// WalkAttrDecode()
// ================

MemoryAttributes WalkAttrDecode(bits(2) SH, bits(2) ORGN, bits(2) IRGN, boolean secondstage)

    MemoryAttributes mematttrs;

    AccType acctype = AccType_NORMAL;

    mematttrs.memtype = MemType_Normal;
    mematttrs.inner = ShortConvertAttrsHints(IRGN, acctype, secondstage);
    mematttrs.outer = ShortConvertAttrsHints(ORGN, acctype, secondstage);
    mematttrs.shareable = SH<1> == '1';
    mematttrs.outershareable = SH == '10';
    mematttrs.tagged = FALSE;

    return MemAttrDefaults(mematttrs);
```

Library pseudocode for shared/translation/translation/HasS2Translation

```
// HasS2Translation()
// ==================
// Returns TRUE if stage 2 translation is present for the current translation regime

boolean HasS2Translation()
    return (EL2Enabled() && !IsInHost() && PSTATE.EL IN {EL0,EL1});
```

Library pseudocode for shared/translation/translation/Have16bitVMID

```
// Have16bitVMID()
// ===============
// Returns TRUE if EL2 and support for a 16-bit VMID are implemented.

boolean Have16bitVMID()
    return HaveEL(EL2) && boolean IMPLEMENTATION_DEFINED;
```

Library pseudocode for shared/translation/translation/PAMax

```
// PAMax()
// =======
// Returns the IMPLEMENTATION DEFINED upper limit on the physical address
// size for this processor, as log2().

integer PAMax()
    return integer IMPLEMENTATION_DEFINED "Maximum Physical Address Size";
```

Library pseudocode for shared/translation/translation/S1TranslationRegime

```
// S1TranslationRegime()
// =====================
// Stage 1 translation regime for the given Exception level

bits(2) S1TranslationRegime(bits(2) el)
    if el != EL0 then
        return el;
    elsif HaveEL(EL3) && ELUsingAArch32(EL3) && SCR.NS == '0' then
        return EL3;
    elsif HaveVirtHostExt() && ELIsInHost(el) then
        return EL2;
    else
        return EL1;

// S1TranslationRegime()
// =====================
// Returns the Exception level controlling the current Stage 1 translation regime. For the most
// part this is unused in code because the system register accessors (SCTLR[], etc.) implicitly
// return the correct value.

bits(2) S1TranslationRegime()
    return S1TranslationRegime(PSTATE.EL);
```

Library pseudocode for shared/translation/translation/VAMax

```
// VAMax()
// =======
// Returns the IMPLEMENTATION DEFINED upper limit on the virtual address
// size for this processor, as log2().

integer VAMax()
    return integer IMPLEMENTATION_DEFINED "Maximum Virtual Address Size";
```

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