

Qualcomm[®] Hexagon[™] V68 HVX

Programmer's Reference Manual

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1 Introduction

This document describes the Qualcomm® Hexagon™ Vector eXtensions (HVX) instruction set architecture. These extensions are implemented in an optional coprocessor. This document assumes the reader is familiar with the Hexagon architecture. For a full description of the architecture, refer to the *Qualcomm Hexagon Programmer's Reference Manual*.

1.1 SIMD coprocessor

HVX instructions are primarily implemented in a single instruction multiple data (SIMD) coprocessor block that includes vector registers, vector compute elements, and dedicated memory. This extends the baseline Hexagon architecture to enable high-performance computer vision, image processing, or other workloads that can be mapped to SIMD parallel processing.

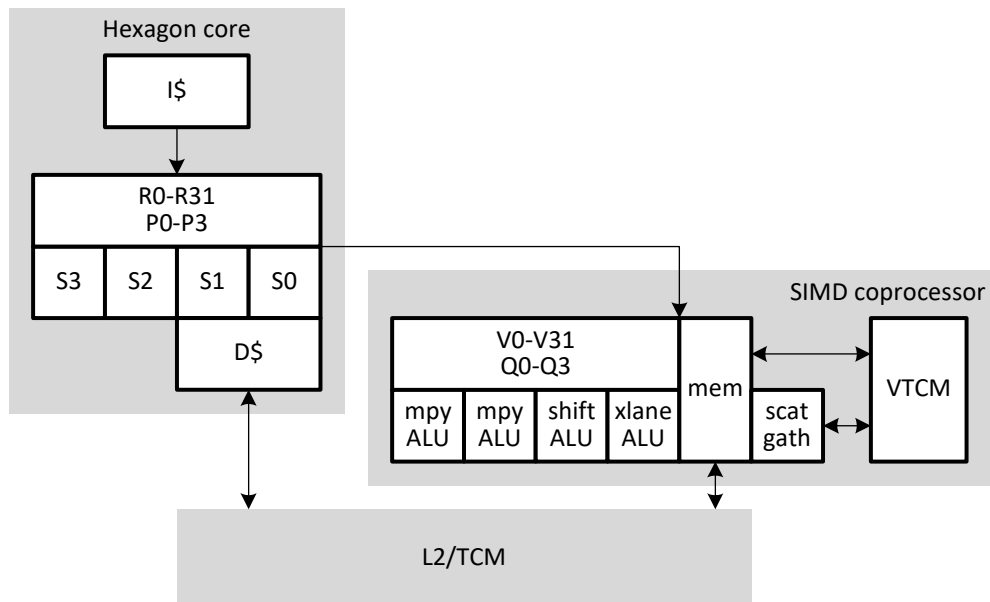


Figure 1-1 Hexagon core with attached SIMD coprocessor

The Hexagon instruction set architecture (ISA) is extended with HVX instructions. These instructions use HVX compute resources and can freely mix with normal Hexagon instructions in a very long instruction word (VLIW) packet. HVX instructions can also use scalar source operands from the core.

1.2 HVX features

HVX adds very wide SIMD capability to the Hexagon ISA. SIMD operations execute on vector registers (currently up to 1024 bits each), and multiple SIMD instructions can execute in parallel.

The main features of HVX are described in the following subsections.

1.2.1 Vector length

HVX supports 1024-bit vectors (128 B). Additional vector sizes may be supported in the future. To minimize porting effort, software should strive to treat vector length as an arbitrary constant power of two.

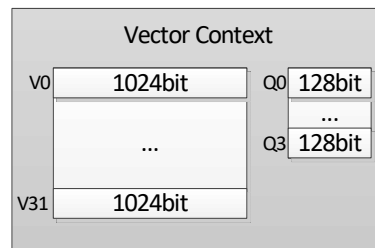


Figure 1-2 Registers using 128 byte mode with a vector length of 1024 bits

1.2.2 Vector contexts

A vector context consists of a vector register file, vector predicate file, and the ability to execute instructions using this state.

Hexagon hardware threads dynamically attach to a vector context; this enables the thread to execute HVX instructions. Multiple hardware threads can execute in parallel, each with a different vector context. The number of supported vector contexts is implementation-defined.

The Hexagon scalar core can contain any number of hardware threads greater or equal to the number of vector contexts. The scalar hardware thread is assignable to a vector context through per-thread SSR:XA programming, as follows:

- SSR:XA=4: HVX instructions use vector context 0.
- SSR:XA=5: HVX instructions use vector context 1, if it is available.
- SSR:XA=6: HVX instructions use vector context 2, if it is available.
- SSR:XA=7: HVX instructions use vector context 3, if it is available.

Figure 1-3 shows a vector context configuration with four hardware threads, but with two of the threads configured to use 128 B vectors. In this configuration, two of the threads can execute 128 vector instructions, while the other two threads can execute scalar-only instructions.

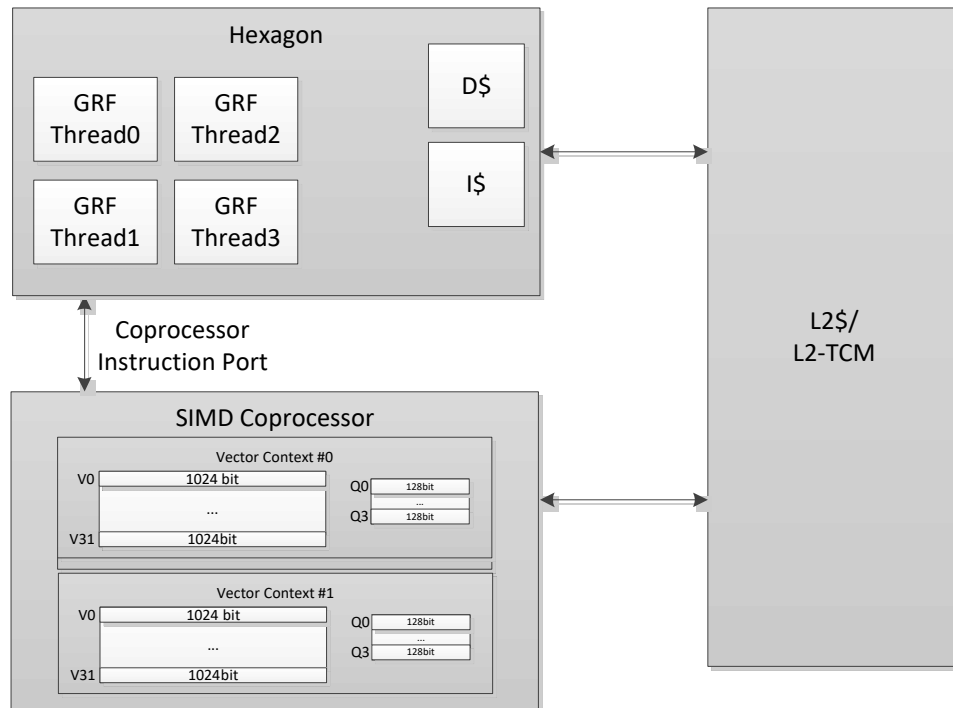


Figure 1-3 Four hardware threads (two HVX-enabled threads and two scalar-only threads)

1.2.3 Memory access

The HVX memory instructions (referred to as VMEM instructions) use the Hexagon general registers [R0:R31] to form addresses that access memory. The memory access size of these instructions is the vector length or the size of a vector register.

VMEM loads and stores share a 32-bit virtual address space as normal scalar load/stores. VMEM load/stores are coherent with scalar load/stores and hardware maintains coherency.

1.2.4 Vector registers

HVX has two sets of registers:

- Data registers consist of 32 vector length registers. Certain operations can access a pair of registers to double the vector length for the operand.
- Predicate registers consist of 4 registers each with 1 bit per byte of vector length. These registers provide operands to various compare, mux, and other special instructions.

The vector registers are partitioned into lanes that operate in SIMD fashion. For example, with 1024-bit (128 B) vector length, each vector register can contain any of following items:

- 32 words (32-bit elements)
- 64 half-words (16-bit elements)
- 128 bytes (8-bit elements)

Element ordering is little-endian with the lowest byte in the least-significant position, as shown in [Figure 1-4](#).

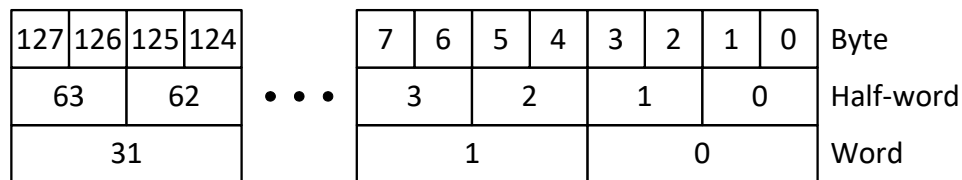


Figure 1-4 1024-bit SIMD register

1.2.5 Vector compute instructions

Vector instructions process vector register data in SIMD fashion. The operation is performed on each vector lane in parallel. For example, the following instruction performs a signed ADD operation over each halfword:

```
V2.h = VADD(V3.h, V4.h)
```

In this instruction, the halfwords in V3 are summed with the corresponding halfwords in V4, and the results stored in V2.

When vectors are specified in instructions, the element type is also usually specified:

- .b for signed byte
- .ub for unsigned byte
- .h for signed halfword
- .uh for unsigned halfword
- .w for signed word
- .uw for unsigned word

For example:

```
v0.b = vadd(v1.b, v2.b)           // Add vectors of bytes
v1:0.b = vadd(v3:2.b, v5:4.b)    // Add vector pairs of bytes
v1:0.h = vadd(v3:2.h, v5:4.h)    // Add vector pairs of halfwords
v5:4.w = vmpy(v0.h, v1.h)       // Widening vector 16x16 to 32
                                // multiplies: halfword inputs,
                                // word outputs
```

For operations with mixed element sizes, each operand with the smaller element size uses a single vector register and each operand with the larger element size (double the smaller) uses a vector register pair. One vector in a pair contains even elements and the other odd elements.

1.3 Changes in V68 HVX

The following are updates to the instruction set for V68 HVX:

- Added additional instructions for acceleration of 3x3 convolution
- Scatter release instruction has been deprecated

1.4 Technical assistance

For assistance or clarification on information in this document, submit a case to Qualcomm Technologies, Inc. (QTI) at <https://createpoint.qti.qualcomm.com/>.

If you do not have access to the CDMATech Support website, register for access or send email to support.cdmatech@qti.qualcomm.com.

2 Registers

HVX is a load-store architecture where compute operands originate from registers and load/store instructions move data between memory and registers.

The vector registers are not for addressing or control information, but rather hold intermediate vector computation results. They are only accessible using HVX compute or load/store instructions.

The vector predicate registers contain the decision bits for each 8-bit quantity of the vector data registers.

2.1 Vector data registers

The HVX coprocessor contains 32 vector registers (named V0 through V31). These registers store operand data for all of the vector instructions.

For example:

```
V1 = vmem(R0)           // load a vector of data
                        // from address R0

V4.w = vadd(V2.w, V3.w) // add each word in V2
                        // to corresponding word in V3
```

The vector data registers can be specified as register pairs representing a double-vector of data. For example:

```
V5:4.w = vadd(V3:2.w, V1:0.w) // add each word in V1:0 to
                               // corresponding word in V3:2
```

2.1.1 VRF-GRF transfers

Table 2-1 lists the Hexagon instructions that transfer values between the vector register file (VRF) and the general register file (GRF).

A packet can contain up to two insert instructions or one extract instruction. The extract instruction incurs a long-latency stall and is primarily meant for debug purposes.

Table 2-1 VRF-GRF transfer instructions

Syntax	Behavior	Description
$Rd.w = extractw(Vu, Rs)$	$Rd = Vu.uw[Rs \& 0xF];$	Extract word from a vector into Rd with location specified by Rs. Primarily meant for debug.
$Vx.w = insertw(Rss)$	$Vx.uw[Rss.w[1] \& 0xF] = Rss.w[0];$	Insert word into vector at specified location. The low word in Rss specifies the data to insert, and the upper word specifies the location.

2.2 Vector predicate registers

Vector predicate registers hold the result of vector compare instructions, for example:

$$Q3 = vcmp.eq(V2.w, V5.w)$$

In this case, each 32-bit field of V2 and V5 are compared and the corresponding 4-bit field is set in the corresponding predicate register Q3. For half-word operations, two bits are set per half-word. For byte operations, one bit is set per byte.

The vmux instruction frequently uses vector predicate instruction. This takes each bit in the predicate register and selects the first or second byte in each source, and places it in the corresponding destination output field.

$$V4 = vmux(Q2, V5, V6)$$

3 Memory

The Hexagon unified byte addressable memory has a single 32-bit virtual address space with little-endian format. All addresses, whether used by a scalar or vector operation go through the MMU for address translation and protection.

3.1 Alignment

Unlike on the scalar processor an unaligned pointer (that is, a pointer that is not a multiple of the vector size) does not cause a memory fault or exception. When using a general VMEM load or store, the least-significant bits of the address are ignored.

```
VMEM(R0) = V1 // Store to R0 & ~(0x3F)
```

The intra-vector addressing bits are ignored.

Unaligned loads and stores are also explicitly supported through the VMEMU instruction.

```
V0 = VMEMU(R0) // Load a vector from R0 regardless of alignment
```

3.2 HVX local memory: VTCM

HVX also supports a local memory called VTCM, for scratch buffers and scatter/gather operations. The size of the memory is implementation-defined. The size is discoverable from the configuration table defined in the V68 system architecture specification. VTCM needs normal virtual to physical translation just like other memory. This memory has higher performance and lower power.

Use VTCM for intermediate vector data, or as a temporary buffer. It serves as the input or output of the scatter/gather instructions. The following are advantages of using VTCM as the intermediate buffer:

- Guarantees no eviction (vs. L2 if the set is full)
- Faster than L2\$ (does not have the overhead of cache management, like association)
- Reduces L2\$ pressure
- Lower power than L2\$
- Supports continuous read and write for every packet without contention

In addition to HVX VMEM access, normal Hexagon memory access instructions can access this memory.

The following conditions are invalid for VTCM access:

- Using a page size larger than the VTCM size.
- Attempting to execute instructions from VTCM. This includes speculative access.
- Scalar VTCM access when the HVX fuse is blown (disabled).
- Load-locked or store-conditional to VTCM.
- `memw_phys` load from VTCM while more than one thread is active.
- Accessing VTCM while HVX is not fully powered up or any VTCM banks are asleep.
- Unaligned access crossing between VTCM and non-VTCM pages.

3.3 Scatter and gather

Scatter and gather instructions allow for per-element random access of VTCM memory. Each element can specify an independent address to read (gather) or write (scatter). Gather for HVX is a vector copy from non-contiguous addresses to an aligned contiguous vector location. Gather operations use slot 0 + slot 1 on the scalar side, and HVX load + store resources.

Gather is formed by two instructions, one for reading from VTCM and one for storing to VTCM:

```
{  Vtmp.h = vgather(Rt, Mu, Vv.h)
   vmem(Rs+#1) = Vtmp.new
}
```

If the input data of gather is in DDR, it must first be copied to VTCM and gathered from there. Gather cannot be done directly on DDR or L2\$ contents.

Vector gather (`vgather`) operations transfer elemental copies from a large region in VTCM to a smaller vector-sized region in VTCM. Each instruction can gather up to 64 elements. Gather supports halfword and word granularity. Emulate byte gather through vector predicate instructions using two packets.

Use gather for large lookup tables (up to VTCM size).

Except for scatters and following scatters, these instructions are ordered with the following operations. However, accesses from elements of the same scatter or gather instruction are not ordered. The primary ordered case is loading from a gather result or from a scatter region.

Operations done via scatter or gather usually perform better via scatter.

The following conditions are invalid for scatter or gather access:

- The scatter (write) or gather (read) region covers more than one page or the M source (`length-1`) is negative. An exception is generated otherwise.
- Any of the accesses are not within VTCM. This includes the gather target addresses as well. An exception is generated otherwise.

- Both a gather region instruction and a scatter instruction in the same packet.

3.4 Memory-type

It is illegal for HVX memory instructions (VMEM or scatter/gather) to target device-type memory. If this is done, a VMEM address error exception is raised. It is also illegal to use HVX memory instructions while the MMU is off.

NOTE HVX is designed to work with L2 cache, L2TCM, or VTCM. Mark memory as L2-cacheable for L2 cache data and uncached for data that resides in L2TCM or VTCM.

3.5 Non-temporal

A VMEM instruction can have an optional non-temporal attribute. This is specified in assembly with an `:nt` appendix. Marking an instruction non-temporal indicates to the micro-architecture that the data is no longer needed after the instruction. The cache memory system uses this information to inform replacement and allocation decisions.

3.6 Permissions

Unaligned VMEMU instructions that are naturally aligned only require MMU permissions for the accessed line. The hardware suppresses generating an access to the unused portion.

The byte-enabled conditional VMEM store instruction requires MMU permissions regardless of whether any bytes are performed or not. In other words, the state of the Q register is not considered when checking permissions.

3.7 Ordering

The HVX coprocessor follows the same sequentially consistent memory model as the scalar core for coprocessor packets. Coprocessor threads interleave their coprocessor memory operations with one another in an arbitrary but fair manner. This results in a consistent program order that is globally observable by all threads in the same order.

The only exception to this rule is the scatter operations. Scatter operation memory updates are unordered with respect to each other. Their internal transactions are also unordered.

DMA accesses through the external AXI slave port are also considered non-coherent with the coprocessor threads and require explicit memory synchronizations through the use of the store release or polling of the DMA descriptor done bit by the scalar core.

3.8 Atomicity

Table 3-1 describes the size or alignment of decomposed atomic operations for different types of memory accesses. When an access is not fully atomic, an observer can see atomic components of the access.

Table 3-1 Atomicity of types of memory accesses

Access type	Atomic size
Scalar A mem-op is 2 accesses	Access size
Aligned vector	Base vector size
Unaligned vector	1 B
Scatter	1 B
Scatter-accumulate (read-modify-write)	1 B A larger read-modify-write may be decomposed into multiple equivalent smaller read-modify-writes.
Gather read	1 B
Gather write	1 B

Individual scatter and gather accesses are only guaranteed to be atomic with other scatter or gather accesses.

3.9 Performance considerations

The HVX vector processor is attached directly to the L2 cache. VMEM loads/stores move data to/from L2 and do not use the L1 data cache. To ensure coherency with L1, VMEM stores check L1 and invalidate on hit.

3.9.1 Minimize VMEM access

Accessing data from vector register file (VRF) is far cheaper in cycles and power than accessing data from memory. The simplest way to improve memory system performance is to reduce the number of VMEM instructions. Avoid moving data to/from memory when VRF can host it instead.

3.9.2 Use aligned data

VMEMU instruction access multiple L2 cache lines and are expensive in bandwidth and power. Where possible, align data structures to vector boundaries. Padding the image is often the most effective technique to provide aligned data.

3.9.3 Avoid store to load stalls

A VMEM load instruction that follows a VMEM store to the same address incurs a store-to-load penalty. The store must fully reach L2 before the load starts, thus the penalty can be quite large. To avoid store-to-load stalls, there should be approximately 15 packets of intervening work.

3.9.4 L2FETCH

Use the L2FETCH instruction to prepopulate the L2 with data prior to using VMEM loads.

L2FETCH is best performed in sizes less than 8 KB and issued at least several hundred cycles prior to using the data. An L2FETCH issued too early can evict data before use. In general, prefetching and processing on image rows or tiles works best.

Prefetch all L2 cacheable data used by VMEM, even if it is not used in the computation. Software pipelined loops often overload data unused data. Even though the pad data is not used in computation, the VMEM stalls if it has not been prefetched into L2.

3.9.5 Access data contiguously

Whenever possible, arrange data in memory contiguous access. For example, instead of repeatedly striding through memory, data might be first tiled, striped, or decimated to enable contiguous access.

The following techniques achieve better spatial locality in memory to help avoid various performance hazards:

- Bank conflicts - Lower address bits are typically used for parallel banks of memory. Accessing data contiguously achieves a good distribution of these address bits. If address bits [7:1] are unique across elements within a vector, the operation is conflict-free. Use a vector predicate to mask out any “don't care” values.
- Set aliasing. Caches hold a number of sets identified by lower address bits. Each set has a small number of methods (typically 4 to 8) to help manage aliasing and multithreading.
- Micro-TLB misses. A limited number of pages are remembered for fast translation. Containing data to a smaller number of pages helps translation performance.

3.9.6 Use non-temporal for final data

On the last use of data, use the “:nt” attribute. The cache uses this hint to optimize the replacement algorithm.

3.9.7 Scalar processing of vector data

When a VMEM store instruction produces data, that data is placed into L2 cache and L1 does not contain a valid copy. Thus, if scalar loads must access the data, it first must be fetched into L1.

It is common for algorithms to use the vector engine to produce results that must further process on the scalar core. Use VMEM stores to get the data into L2, then use DCFETCH to get the data in L1, followed by scalar load instructions. Execute the DCFETCH anytime after the VMEM store, however, software should budget at least 30 cycles before issuing the scalar load instruction.

3.9.8 Avoid scatter/gather stalls

Scatter and gather operations compete for memory and can result in long latency, therefore take care to avoid stalls. The following techniques improve performance around scatter and gather:

- Distribute accesses across the intra-vector address range (lower address bits). Even distribution across the least significant inter-vector address bits can be beneficial. For V68, address bits [10:3] are important to avoid conflicts. Ideally this applies per vector instruction, but distributing these accesses out between vector instructions can help absorb conflicts within a vector instruction.
- Minimize the density of scatter and gather instructions. Spread out these instructions in a larger loop rather than concentrating them in a tight loop. The hardware can process a small number of these instructions in parallel. If it is difficult to spread these instructions out, limit bursts to four for a given thread (for V68).
- Defer loading from a gather result or a scatter store release. If the in-flight scatters and gathers (including from other threads) avoid conflicts, generally a distance of 12 or more packets is sufficient. Double that distance if the addresses of in-flight accesses are not correlated.

Table 3-2 Peak scatter/gather performance for v68

Operation	Addressing	Vector bandwidth (per packet)	Latency (packets)
Scatter	Conflict-free	1/2	18
Gather	Conflict-free	1/2	24
Scatter	Random	1/6	30
Gather	Random	1/6	48

4 HVX PMU events

The Hexagon processor architecture defines a performance monitor unit (PMU) to provide on-target performance tracking.

The PMU allows for easy collection of aggregate performance data like cache performance and instructions per packet. This data is valuable for system planning and architecture purposes because it drives various performance and power statistical models.

The PMU can also be configured to track the performance of individual software threads. This is useful when diagnosing performance problems

In V68 and later versions, the PMU event space is expanded to 1024 events. Events 0 to 255 describe core events, and are described in the *Hexagon V68 Architecture System-Level Specification* (80-V9418-28). Coprocessors use events 384 and above; these are described in the *Qualcomm Hexagon V68 Programmer's Reference Manual* (80-N2040-46)

HVX events 256 to 299 are documented in [Table 4-1](#)

Table 4-1 HVX PMU events

Event	Name	Description
256	HVX_ACTIVE	VFIFO not empty
257	HVX_REG_ORDER	Stall cycles due to interlocks
258	HVX_ACC_ORDER	Stall cycles due to accumulator not produced in previous context cycle.
259	HVX_LD_L2_OUTSTANDING	Stall cycles due to load pending
260	HVX_ST_L2_OUTSTANDING	Stall cycles due to store not yet allocated in L2
261	HVX_VTCM_OUTSTANDING	Stall cycles due to VTCM transaction pending.
262	HVX_SCATGATH_FULL	Scatter/gather: network scoreboard not updated
263	HVX_SCATGATH_IN_FULL	Scatter/gather input buffer full
264	HVX_ST_FULL	Store buffer full
265	HVX_VOLTAGE_VIRUS_OVER	Throttling: voltage virus overshoot
266	HVX_VOLTAGE_UNDER	Throttling: voltage model would exceed undershoot threshold
267	HVX_POWER_OVER	Throttling: sustained power exceeds budget
268	HVX_PKT_PARTIAL	Stall cycles due to multi-issue packet
273	HVX_PKT	Packets with HVX instructions

Table 4-1 HVX PMU events

Event	Name	Description
274	HVX_PKT_THREAD	Committed packets on a thread with the XE bit set, whether executed in Q6 or coprocessor
275	HVX_CORE_VFIFO_FULL_STALL	Number of cycles a thread had to stall due to VFIFO
280	HVXLD_L2	L2 cacheable load access from HVX. Any load access from HVX that might cause a lookup in the L2 cache. Excludes cache ops, uncacheables, scalars
281	HVXLD_L2_TCM	TCM load access for HVX. HVX load from the L2 TCM space
282	HVXLD_L2_MISS	L2 cacheable miss from HVX. Of the events qualified by 0xFB, those that resulted in a miss, such as the 64-byte address, were not previously allocated in the L2 tag array and data is fetched from backing memory.
283	HVXLD_L2_SECONDARY_MISS	Events in 0xFB where the load cannot return because the immediately prior access for the line is a pending load or pending L2Fetch.
284	HVXST_L2_WR	Vector write in L2.
285	HVXST_SLD_CONFLICT	Lower priority with respect to scalar load to access L2 return data bus
286	HVXST_VTCM_GATH_CONFLICT	Lower priority with respect to gather.
287	HVXST_L2_CONFLICT	Lost against another partition write to FIFO for L2 interleave.
288	HVXST_VTCM_CONFLICT	Lost against another partition write to FIFO for VTCM interleave.
289	HVXST_L2_FULL	Write FIFO full.
290	HVXST_VTCM_FULL	Write FIFO full.
291	HVXST_L2	Vector store to L2.
292	HVXST_L2_MISS	L2 cacheable miss from HVX store; the cases where the 128-byte-line address is not in the tag or a coalesce buffer.
293	HVXST_L2TCM	TCM store access for HVX. HVX store to the L2 TCM space.
294	HVXST_VTCM	Vector store to VTCM.
295	HVXST_L2_SECONDARY_MISS	L2 cacheable secondary miss from HVX store; the cases where the 128-byte-line address is not in the tag or a coalesce buffer.
296	HVXPIPE_ALU	Executed simple ALU instruction.
297	HVXPIPE_MPY	Executed multiply or abs-diff instruction.
298	HVXPIPE_SHIFT	Executed bit shift or bit count instruction.
299	HVXPIPE_PERM	Executed permute or cross-lane data movement instruction.

5 Vector Instructions

This chapter provides an overview of the HVX load/store instructions, compute instructions, VLIW packet rules, dependency, and scheduling rules.

Section 5.8 gives a summary of all hexagon slot, HVX resource, and instruction latency for all instruction categories.

5.1 VLIW packing rules

HVX provides the following resources for vector instruction execution:

- load
- store
- shift
- permute
- two multiply

Each HVX instruction consumes some combination of these resources, as defined in section 5.1.2. VLIW packets cannot oversubscribe resources.

An instruction packet can contain up to four instructions, plus an endloop. The instructions inside the packet must obey the packet grouping rules described in section 5.1.3.

NOTE The assembler should check and flag invalid packet combinations. When an invalid packet execute, the behavior is undefined.

5.1.1 Double vector instructions

Certain instructions consume a pair of resources, either both the shift and permute as a pair or both multiply resources as another pair. Such instructions are referred to as double vector instructions because they use two vector compute resources.

Halfword by halfword multiplies are double vector instructions, because they consume both the multiply resources.

5.1.2 Vector instruction resource usage

The following table summarizes the resources that an HVX instruction uses during execution. It also specifies the order in which the Hexagon assembler tries to build an instruction packet from the most to least stringent.

Table 5-1 HVX execution resource usage

Instruction	Used resources
Histogram	All
Unaligned memory access	Load, store, and permute
Double vector cross-lane permute	Permute and shift
Cross-lane permute	Permute
Shift	Shift
Double vector & halfword multiplies	Both multiply
Single vector	Either multiply
Double vector ALU operation	Either shift and permute or both multiply
Single vector ALU operation	Any one of shift, permute, or multiply
Aligned memory	Any one of shift, permute, or multiply and one of load or store
Aligned memory (.tmp/.new)	Load or store only
Scatter (single vector indexing)	Store and any one of shift, permute, or multiply
Scatter (double vector indexing)	Store and either shift and permute or both multiply
Gather (single vector indexing)	Load and any one of shift, permute, or multiply
Gather (double vector indexing)	Load and either shift and permute or both multiply

5.1.3 Vector instruction

In addition to vector resource assignment, vector instructions map to certain Hexagon slots. A special subset of ALU instructions that require either the full 32 bits of the scalar Rt register (or 64 bits of Rtt) map to slots 2 and 3. These include lookup table, splat, insert, and add/sub with Rt.

Table 5-2 HVX instruction to Hexagon slots mapping

Instruction	Used Hexagon slots	Additional restriction
Aligned memory load	0 or 1	
Aligned memory store	0	
Unaligned memory load/store	0	Slot 1 must be empty. Maximum of 3 instructions allowed in the packet.
Scatter	0	
Gather	1	.new store in slot 0
Vextract	-	Only instruction in packet

Table 5-2 HVX instruction to Hexagon slots mapping

Instruction	Used Hexagon slots	Additional restriction
Histogram	0, 1, 2, or 3	.tmp load in same packet
Multiplies	2 or 3	
Using full 32-64 bit R	2 or 3	
Simple ALU, permute, shift	0, 1, 2, or 3	

5.2 Vector load/store

VMEM instructions move data between VRF and memory. VMEM instructions support the following addressing modes.

- Indirect
- Indirect with offset
- Indirect with auto-increment (immediate and register/modifier register)

For example:

```
V2 = vmem(R1+#4) // address R1 + 4 * (vector-size) bytes
V2 = vmem(R1++M1) // address R1, post-modify by the value of M1
```

The immediate increment and post increment values are vector counts. So the byte offset is in multiples of the vector length.

To facilitate unaligned memory access, unaligned load and stores are available. The VMEMU instructions generate multiple accesses to the L2 cache and use the permute network to align the data.

The “load-temp” and “load-current” forms allow immediate use of load data within the same packet. A “load-temp” instruction does not write the load data into the register file (A register must be specified, but it is not overwritten). Since the “load-temp” instruction does not write to the register file, it does not consume a vector ALU resource.

```
{ V2.tmp = vmem(R1+#1) // Data loaded into a tmp
  V5:4.ub = vadd(V3.ub, V2.ub) // Use loaded data as V2 source
  V7:6.uw = vrmpy(V5:4.ub, R5.ub, #0)
}
```

“Load-current” is similar to “load-temp”, but consumes a vector ALU resource as the loaded data is written to the register file

```
{ V2.cur = vmem(R1+#1) // Data loaded into a V2
  V3 = valign(V1,V2, R4) // load data used immediately
  V7:6.ub = vrmpy(V5:4.ub, R5.ub,#0)
}
```

VMEM store instructions can store a newly generated value. They do not consume a vector ALU resource as they do not read nor write the register file.

The register used for the new value VMEM store is encoded in a field in the store instruction. The store is always slot 0, and scalar instructions are skipped when counting the offset. Bit 0 corresponds to either the even (0) or odd (1) register of the pair.

```
vmem(R1+#1) = V20.new // Store V20 that was generated in the current
packet
```

An entire VMEM write can be suppressed by a scalar predicate.

```
if P0 vmem(R1++M1) = V20 // Store V20 if P0 is true
```

A partial byte-enabled store can be issued and controlled with a vector predicate register.

```
if Q0 vmem(R1++M1) = V20 // Store bytes of V20 where Q0 is true
```

5.3 Scatter and gather

Unlike vector loads and stores that access contiguous vectors in memory, scatter and gather allow for noncontiguous memory access of vector data. With scatter and gather, each element can independently index into a region of memory. This allows for applications that would not otherwise map well to the SIMD parallelism that HVX provides.

A scatter transfers data from a contiguous vector to noncontiguous memory locations. Similarly, gather transfers data from noncontiguous memory locations to a contiguous vector. In HVX, scatter is a vector register to noncontiguous memory transfer and gather is a noncontiguous memory to contiguous memory transfer. Additionally, HVX supports scatter-accumulate instructions that atomically add.

To maximize performance and efficiency, the scatter and gather instructions define a bounded region that must contain all noncontiguous accesses. This region must be within VTCM (scatter/gather capable) and be within one translatable page. A vector specifies offsets from the base of the region for each element access. The following table describes the three sources that specify the noncontiguous accesses of a scatter or gather:

Table 5-3 Sources for non-contiguous accesses: (Rt, Mu, Vv)

Source	Meaning
Rt	Base address of the region
Mu	Byte offset of last valid byte of the region (region size - 1)
Vv or Vvv	Vector of byte offsets for the accesses. Double-vector is used when the offset width is double the data width

To form an HVX gather (memory to memory), `vgather` pairs with a vector store to specify the destination address. A scatter is specified with a single instruction. Ignoring element sizes, the following table describes the basic forms of scatter and gather instructions:

Table 5-4 Basic scatter and gather instructions

Instruction	Behavior
<code>vscatter(Rt,Mu,Vv)=Vw</code>	Write data in <code>Vw</code> to noncontiguous addresses specified by <code>(Rt,Mu,Vv)</code>
<code>vscatter(Rt,Mu,Vv)+=Vw</code>	Atomically add data in <code>Vw</code> to noncontiguous addresses specified by <code>(Rt,Mu,Vv)</code>
<pre>{ vtmp=vgather(Rt,Mu,Vv); vmem(Addr)=vtmp.new }</pre>	Read data from noncontiguous addresses specified by <code>(Rt,Mu,Vv)</code> and write the data contiguously to the aligned <code>Addr</code>

5.4 Memory instruction slot combinations

VMEM load/store instructions and scatter/gather instructions can be grouped with normal scalar load/store instructions.

[Table 5-5](#) provides the valid grouping combinations for HVX memory instructions. A combination that is not present in the table is invalid, and should be rejected by the assembler. The hardware generates an invalid packet error exception.

Table 5-5 Valid VMEM load/store and scatter/gather combinations

Slot 0 Instruction	Slot 1 Instruction
VMEM Ld	Non-memory
VMEM St	Non-memory
VMEM Ld	Scalar Ld
Scalar St	VMEM Ld
Scalar Ld	VMEM Ld
VMEM St	Scalar St
VMEM St	Scalar Ld
VMEM St	VMEM Ld
VMEMU Ld	Empty
VMEMU St	Empty
.new VMEM St	Gather
Scatter	Non-memory
Scatter	Scalar St
Scatter	Scalar Ld
Scatter	VMEM Ld

5.5 Special instructions

5.5.1 Histogram

HVX contains a specialized histogram instruction. The vector register file is divided into four histogram tables each of 256 entries (32 registers by 8 halfwords). A temporary VMEM load instruction fetches a line from memory. The top five bits of each byte provide a register select, and the bottom bits provide an element index. The value of the element in the register file is incremented. The programmer must clear all of the registers before use.

The following example uses the histogram instruction:

```
{  V31.tmp = VMEM(R2) // load a vector of data from memory
   VHIST();// Perform histogram using counters in VRF and indexes from temp load
}
```

5.6 QFloat

V68 HVX architecture introduces the QFloat floating point format that offers similar dynamic range and precision to that of IEEE-754. However, there are significant differences, as QFloat is designed to be more hardware efficient.

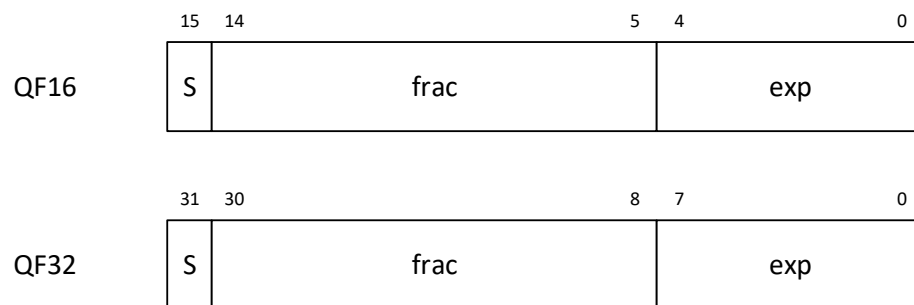


Figure 5-1 QFloat format

The QFloat format has the following properties:

- The fractional field is two's complement fixed-point format.
- There is no implied MSB in the significand as there is in IEEE. The fractional field only encodes o.frac.
- QFloat implements Von Neumann rounding, where the implied least significant bit of the fractional field is an implicit one.
- There is no concept of infinity or NaN. QFloat saturates to maximum exponent with maximum positive or minimum negative significand.

- The QFloat format has one bit less of precision compared to IEEE for most algorithms.

Table 5-6 summarizes the differences between IEEE and QFloat.

Table 5-6 Differences between IEEE and QFloat

Features	IEEE - 754	QFloat
Bits	1 + exp + mantissa	1 + mantissa + exp
Positive zero	Yes (subnormal)	Rounded to +tiniest
Negative zero	Yes (subnormal)	Rounded to -tiniest
Significant bits	Mantissa + 1	Mantissa + 1 (limited by round)
Subnormal/zero	W/exp=min	Un-normals natural
Infinity/NaN	W/exp=max	Saturated
Lg (max/min)	2^{E-2+M}	2^{E+M}
Unique finite values	$(2^{E-1}) * 2^M - 1$	$2^E * 2^M$
Rounding	Nearest even	Nearest odd or odd-even
Use with QFloat	Input and conversion/storage	Compute

QFloat instructions make use of the same shift and multiply resources as other HVX instructions.

5.6.1 QFloat best practices

Treat QFloat like an intermediate format, where the input and output of an algorithm are in an IEEE format (single or half precision).

The QFloat instruction set supports IEEE float values as inputs on the vector operands. The intermediate computations of an algorithm are performed in native QFloat. The final output is converted back to IEEE through explicit convert instructions before storing to memory.

- Performing a normalization step prior to a multiply is beneficial when expecting massive cancellation in a prior addition or subtraction step.

5.7 Instruction latency

Latencies are implementation-defined and can change with future versions.

HVX packets execute over multiple clock cycles, but typically in a pipelined manner so that a packet can be issued and completed on every context cycle. The contexts are time interleaved to share the hardware such that using all contexts may be required to reach peak compute bandwidth.

With a few exceptions (histogram and extract), results of packets generate within a fixed time after execution starts. But, when the sources are required varies. Instructions that need more pipelining require early sources. Only HVX registers are early source registers. Early source operands include:

- Input to the multiplier. For example `V3.h = vmpyh(V2.h, V4.h)`. V2 and V4 are multiplier inputs. For multiply instructions with accumulation, the accumulator is not considered an early source multiplier input.
- Input to shift/bit count instructions. Only the register to shift or count is considered early source. Accumulators are not early sources.
- Input to permute instructions. Only registers to permute are considered early source (not an accumulator).
- Unaligned store data is an early source.

An early source register produced in the previous vector packet can incur an interlock stall. Software should strive to schedule an intervening packet between the producer and an early source consumer.

The following example shows various interlock cases:

```
V8 = VADD(V0, V0)
V0 = VADD(V8, V9) // NO STALL
V1 = VMPY(V0, R0) // STALL due to V0
V2 = VSUB(V2, V1) // NO STALL on V1
V5:4 = VUNPACK(V2) // STALL due to V2
V2 = VADD(V0, V4) // NO STALL on V4
```

5.8 Slot/resource/latency summary

Table 5-7 summarizes the Hexagon slot, HVX resource, and latency requirements for all HVX instruction types.

Table 5-7 HVX slot/resource/latency summary

Category	Variation	Core slots				Vector resources					Input latency	
		3	2	1	0	ld	mpy	mpy	shift	xlane		st
ALU	1 vec	any				any					1	
	2 vec	any				either pair					1	
	Rt	either				either						1
Abs-diff	1 vec	either				either						2
	2 vec	either										2
Multiply	by 8b; 1 vec	either				either						2
	by 8b; 2 vec	either										2
	by 16b	either										2
Cross-lane	1 vec	any										2
	2 vec	any										2
Shift or count	1 vec	any										2
load	aligned			either			any				-	
	aligned; .tmp			either			any				-	
	aligned; .cur			either			any				-	
	unaligned											-
store	aligned						any				1	
	aligned; .new											0
	unaligned											2
gather (needs .new store)	1 vec						any				1	
	2 vec						either pair				1	
scatter	1 vec						any				1	
	2 vec						either pair				1	
histogram (needs .tmp load)		any										2
extract												1

6 HVX Instruction Set

The instructions for version 6 of the Hexagon processor are listed alphabetically within instruction categories. The following information is provided for each instruction:

- Instruction name
- A brief description of the instruction
- A high-level functional description (syntax and behavior) with all possible operand types
- Instruction class and slot information for grouping instructions in packets
- Notes on miscellaneous issues
- Any C intrinsic functions that provide access to the instruction
- Instruction encoding

Table 6-1 lists the symbols used to specify the instruction syntax.

Table 6-1 Instruction syntax symbols

Symbol	Example	Meaning
=	R2 = R3;	Assignment of RHS to LHS
;	R2 = R3;	Marks the end of an instruction or group of instructions
{ ... }	{R2 = R3; R5 = R6;}	Indicates a group of parallel instructions.
#	#100	Immediate constant value
0x	R2 = #0x1fe;	Indicates hexadecimal number
:sat	R2 = add(r1,r2):sat	Perform optional saturation
:rnd	R2 = mpy(r1.h,r2.h):rnd	Perform optional rounding

Table 6-2 lists the symbols used to specify instruction operands.

Table 6-2 Instruction operand symbols

Symbol	Example	Meaning
#uN	R2 = #u16	Unsigned N-bit immediate value
#sN	R2 = add(R3,#s16)	Signed N-bit immediate value

When an instruction contains more than one immediate operand, the operand symbols are specified in upper and lower case (for example, #uN and #UN) to indicate where they appear in the instruction encodings.

The instruction behavior is specified using a superset of the C language. [Table 6-3](#) lists symbols not defined in C which are used to specify the instruction behavior.

Table 6-3 Instruction behavior symbols

Symbol	Example	Meaning
usat_N	usat_16(Rs)	Saturate a value to an unsigned N-bit
sat_N	sat_16(Rs)	Saturate a value to a signed N-bit number
sxt x->y	sxt32->64(Rs)	Sign-extend value from x to y bits
zxt x->y	zxt32->64(Rs)	Zero-extend value from x to y bits
>>>	Rss >>> offset	Logical right shift

6.1 HVX/ALL-COMPUTE-RESOURCE

The HVX/ALL-COMPUTE-RESOURCE instruction subclass includes ALU instructions that use a pair of HVX resources.

Histogram

The `vhist` instructions use the HVX core resources: the register file, V0-V31, and all four instruction pipes. The instruction takes four execution packets to complete. The basic unit of the histogram instruction is a 128-bit wide slice - there can be 4 or 8 slices, depending on the particular configuration. The 32 vector registers are configured as multiple 256-entry histograms, where each histogram bin has a width of 16 bits. This allows up to 65535 8-bit elements of the same value to accumulate.

Each histogram is 128 bits wide and 32 elements deep, giving a total of 256 histogram bins. A vector is read from memory and stored in a temporary location, outside of the register file. The data read is then divided equally between the histograms. For example:

Bytes 0 to 15 profile into bits 0 to 127 of all 32 vector registers, histogram 0.

Bytes 16 to 31 profile into bits 128 to 255 of all 32 vector registers, histogram 1.

... and so on.

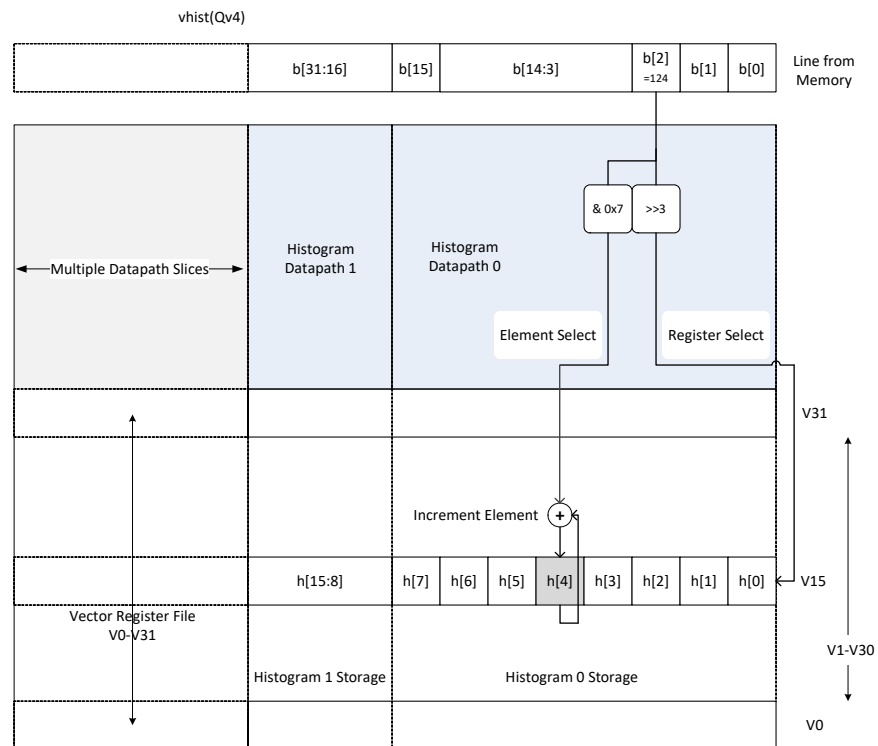
The bytes are processed over multiple cycles to update the histogram bins. For each of the histogram slices, the lower three bits of each byte element in the 128-bit slice selects the 16-bit position, while the upper 5 bits select the vector register. The register file entry is then incremented by one.

The `vhist` instruction is the only instruction that occupies all pipes and resources.

Before use, the vector register file must be cleared if a new histogram is to begin, otherwise the current state is added to the histograms of the next data.

The `vhist` instruction supports the same addressing modes as standard loads. In addition, a byte-enabled version is available that enables the selection of the elements used in the accumulation.

The following diagram shows a single 8-bit element in position 2 of the source data.



The value is 124, the assigned register number is $124 \gg 3 = V15$. The element number in the register is $124 \& 7 = 4$. The byte position in the example is 2, which is in the first 16 bytes of the input line from memory, so the data affects the first 128-bit wide slice of the register file. The 16-bit histogram bin location is then incremented by 1. Each 64-bit input group of bytes affects the respective 128-bit histogram slice.

For a 64 byte vector size, peak total consumption is $64(\text{bytes per vector})/4(\text{packets per operation}) * 4(\text{threads}) = 64$ bytes per clock cycle per core, assuming threads are performing histogramming.

Syntax

```
vhist
```

Behavior

```
inputVec=Data from .tmp load;
for (lane = 0; lane < VELEM(128); lane++) {
    for (i=0; i<128/8; ++i) {
        unsigned char value =
inputVec.ub[(128/8)*lane+i];
        unsigned char regno = value>>3;
        unsigned char element = value & 7;
        READ_EXT_VREG(regno,tmp,0);
        tmp.uh[(128/16)*lane+(element)]++;
        WRITE_EXT_VREG(regno,tmp,EXT_NEW);
    }
}
```

Syntax

vhist(Qv4)

Behavior

```

inputVec=Data from .tmp load;
for (lane = 0; lane < VELEM(128); lane++) {
  for (i=0; i<128/8; ++i) {
    unsigned char value =
inputVec.ub[(128/8)*lane+i];
    unsigned char regno = value>>3;
    unsigned char element = value & 7;
    READ_EXT_VREG(regno,tmp,0);
    if (QvV[128/8*lane+i])
tmp.uh[(128/16)*lane+(element)]++;
    WRITE_EXT_VREG(regno,tmp,EXT_NEW);
  }
}

```

Class: COPROC_VX (slots 0,1,2,3)**Encoding**

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	
ICLASS																Parse																
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	-	0	0	0	-	1	0	0	-	-	-	-	-	vhist
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	-	-	0	0	-	1	0	0	-	-	-	-	-	vhist(Qv4)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
v2	Field to encode register v

Weighted histogram

The `vwhist` instructions use all of the HVX core resources: the register file, V0-V31, and all four instruction pipes. The instruction also takes four execution packets to complete. The basic unit of the histogram instruction is a 128-bit wide slice - there can be 4 or 8 slices, depending on the particular configuration. The 32 vector registers are configured as multiple 256-entry histograms for `vwhist256`, where each histogram bin has a width of 16 bits. Each histogram is 128 bits wide and 32 elements deep, giving a total of 256 histogram bins. For `vwhist128`, the 32 vector registers are configured as multiple 128-entry histograms where each histogram bin has a width of 32 bits. Each histogram is 128 bits wide and 16 elements deep, giving a total of 128 histogram bins.

A vector is read from memory and stored in a temporary location, outside of the register file. The vector carries both the data used for the index into the histogram and the weight. The data occupies the even byte of each halfword and the weight the odd byte of each halfword. The data read is then divided equally between the histograms. For example:

Even bytes 0 to 15 are profiled into bits 0 to 127 of all 32 vector registers, histogram 0.

Even bytes 16 to 31 are profiled into bits 128 to 255 of all 32 vector registers, histogram 1.

... and so on.

The bytes are processed over multiple cycles to update the histogram bins. For each of the histogram slices in `vwhist256`, the lower three bits of each even byte element in the 128-bit slice selects the 16-bit position, while the upper five bits select the vector register.

For each of the histogram slices in `vwhist128`, bits 2:1 of each even byte element in the 128-bit slice select the 32-bit position, while the upper five bits select the vector register. The LSB of the byte is ignored.

The register file entry is then incremented by corresponding weight from the odd byte.

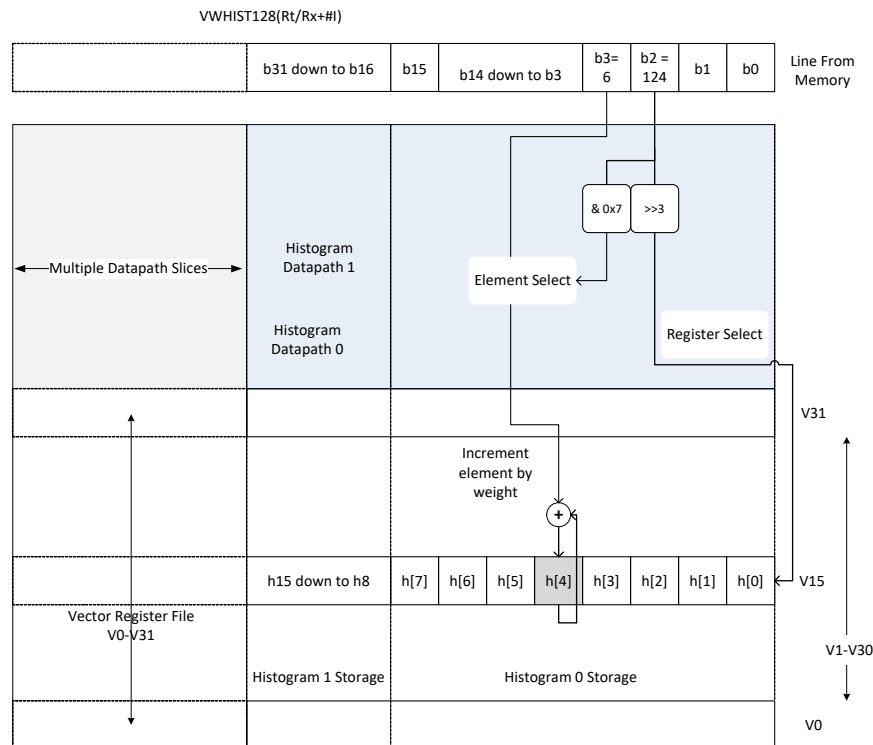
Like `vhist`, `vwhist` also occupies all pipes and resources.

Before use, the vector register file must be cleared if a new histogram is to begin, otherwise the current state is added to the histograms of the next data.

`vwhist` supports the same addressing modes as standard loads. In addition, a byte-enabled version is available that enables the selection of the elements used in the accumulation.

The following diagram shows a single 8-bit element in byte position 2 of the source data with corresponding weight in byte position 3. The value is 124, the register number assigned to this is $124 \gg 3 = V15$, and the element number in the register is $124 \& 7 = 4$. The byte position in the example is 2, which is in the first 16 bytes of the input line from memory, so the data affects the first 128-bit wide slice of the register file. The 16-bit histogram bin location is then incremented by the weight from byte position 3. Each 64-bit input group of bytes affects the respective 128-bit histogram slice.

For a 64 byte vector size, peak total consumption is $64(\text{bytes per vector})/4(\text{packets per operation}) * 4(\text{threads}) = 64$ bytes per clock cycle per core, assuming all threads are performing histogramming.

**Syntax**

```
vwhist128
```

Behavior

```
input = Data from .tmp load;
{
  for (i = 0; i < VELEM(16); i++) {
    bucket = input.h[i].ub[0];
    weight = input.h[i].ub[1];
    vindex = (bucket >> 3) & 0x1F;
    elindex = ((i >> 1) & (~3)) | ((bucket >> 1) & 3);
    READ_EXT_VREG(vindex, tmp, 0);
    tmp.uw[elindex] = (tmp.uw[elindex] + weight);
    WRITE_EXT_VREG(vindex, tmp, EXT_NEW);
  }
}
```

```
vwhist128(#u1)
```

```
input = Data from .tmp load;
{
  for (i = 0; i < VELEM(16); i++) {
    bucket = input.h[i].ub[0];
    weight = input.h[i].ub[1];
    vindex = (bucket >> 3) & 0x1F;
    elindex = ((i >> 1) & (~3)) | ((bucket >> 1) & 3);
    READ_EXT_VREG(vindex, tmp, 0);
    if ((bucket & 1) == #u) tmp.uw[elindex] =
      (tmp.uw[elindex] + weight);
    WRITE_EXT_VREG(vindex, tmp, EXT_NEW);
  }
}
```

Syntax	Behavior
<code>vwhist128(Qv4)</code>	<pre> input = Data from .tmp load; { for (i = 0; i < VELEM(16); i++) { bucket = input.h[i].ub[0]; weight = input.h[i].ub[1]; vindex = (bucket >> 3) & 0x1F; elindex = ((i>>1) & (~3)) ((bucket>>1) & 3); READ_EXT_VREG(vindex,tmp,0); if (QvV[2*i]) tmp.uw[elindex] = (tmp.uw[elindex] + weight); WRITE_EXT_VREG(vindex,tmp,EXT_NEW); } } </pre>
<code>vwhist128(Qv4,#u1)</code>	<pre> input = Data from .tmp load; { for (i = 0; i < VELEM(16); i++) { bucket = input.h[i].ub[0]; weight = input.h[i].ub[1]; vindex = (bucket >> 3) & 0x1F; elindex = ((i>>1) & (~3)) ((bucket>>1) & 3); READ_EXT_VREG(vindex,tmp,0); if (((bucket & 1) == #u) && QvV[2*i]) tmp.uw[elindex] = (tmp.uw[elindex] + weight); WRITE_EXT_VREG(vindex,tmp,EXT_NEW); } } </pre>
<code>vwhist256</code>	<pre> input = Data from .tmp load; { for (i = 0; i < VELEM(16); i++) { bucket = input.h[i].ub[0]; weight = input.h[i].ub[1]; vindex = (bucket >> 3) & 0x1F; elindex = ((i>>0) & (~7)) ((bucket>>0) & 7); READ_EXT_VREG(vindex,tmp,0); tmp.uh[elindex] = (tmp.uh[elindex] + weight); WRITE_EXT_VREG(vindex,tmp,EXT_NEW); } } </pre>
<code>vwhist256(Qv4)</code>	<pre> input = Data from .tmp load; { for (i = 0; i < VELEM(16); i++) { bucket = input.h[i].ub[0]; weight = input.h[i].ub[1]; vindex = (bucket >> 3) & 0x1F; elindex = ((i>>0) & (~7)) ((bucket>>0) & 7); READ_EXT_VREG(vindex,tmp,0); if (QvV[2*i]) tmp.uh[elindex] = (tmp.uh[elindex] + weight); WRITE_EXT_VREG(vindex,tmp,EXT_NEW); } } </pre>

Syntax

vwhist256(Qv4):sat

Behavior

```

input = Data from .tmp load;
{
  for (i = 0; i < VELEM(16); i++) {
    bucket = input.h[i].ub[0];
    weight = input.h[i].ub[1];
    vindex = (bucket >> 3) & 0x1F;
    elindex = ((i>>0) & (~7)) | ((bucket>>0) & 7);
    READ_EXT_VREG(vindex,tmp,0);
    if (QvV[2*i]) tmp.uh[elindex] =
usat_16(tmp.uh[elindex] + weight);
    WRITE_EXT_VREG(vindex,tmp,EXT_NEW);
  }
}

```

vwhist256:sat

```

input = Data from .tmp load;
{
  for (i = 0; i < VELEM(16); i++) {
    bucket = input.h[i].ub[0];
    weight = input.h[i].ub[1];
    vindex = (bucket >> 3) & 0x1F;
    elindex = ((i>>0) & (~7)) | ((bucket>>0) & 7);
    READ_EXT_VREG(vindex,tmp,0);
    tmp.uh[elindex] = usat_16(tmp.uh[elindex] +
weight);
    WRITE_EXT_VREG(vindex,tmp,EXT_NEW);
  }
}

```

Class: COPROC_VX (slots 0,1,2,3)**Encoding**

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	
ICLASS																Parse																
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	-	0	0	1	0	1	0	0	-	-	-	-	-	vwhist256
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	-	0	0	1	1	1	0	0	-	-	-	-	-	vwhist256:sat
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	-	0	1	0	-	1	0	0	-	-	-	-	-	vwhist128
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	-	0	1	1	i	1	0	0	-	-	-	-	-	vwhist128(#u1)
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	-	-	0	1	0	1	0	0	-	-	-	-	-	vwhist256(Qv4)
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	-	-	0	1	1	1	0	0	-	-	-	-	-	vwhist256(Qv4):sat
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	-	-	1	0	-	1	0	0	-	-	-	-	-	vwhist128(Qv4)
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	-	-	1	1	i	1	0	0	-	-	-	-	-	vwhist128(Qv4,#u1)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
v2	Field to encode register v

6.2 HVX/ALU-DOUBLE-RESOURCE

The HVX/ALU-DOUBLE-RESOURCE instruction subclass includes ALU instructions that use a pair of HVX resources.

Predicate operations

Perform bitwise logical operations between two vector predicate registers Qs and Qt, and place the result in Qd. The operations are element-size agnostic.

The following combinations are implemented: Qs & Qt, Qs & !Qt, Qs | Qt, Qs | !Qt, Qs ^ Qt. Interleave predicate bits from two vectors to match a shuffling operation like vsat or vround. Forms are available that match word-to-halfword and halfword-to-byte shuffling.

Syntax	Behavior
<code>Qd4.b=vshufffe(Qs4.h,Qt4.h)</code>	<pre>for (i = 0; i < VELEM(8); i++) { QdV[i]=(i & 1) ? QsV[i-1] : QtV[i] ; }</pre>
<code>Qd4.h=vshufffe(Qs4.w,Qt4.w)</code>	<pre>for (i = 0; i < VELEM(8); i++) { QdV[i]=(i & 2) ? QsV[i-2] : QtV[i] ; }</pre>
<code>Qd4=and(Qs4, [!]Qt4)</code>	<pre>for (i = 0; i < VELEM(8); i++) { QdV[i]=QsV[i] && [!]QtV[i] ; }</pre>
<code>Qd4=or(Qs4, [!]Qt4)</code>	<pre>for (i = 0; i < VELEM(8); i++) { QdV[i]=QsV[i] [!]QtV[i] ; }</pre>
<code>Qd4=xor(Qs4,Qt4)</code>	<pre>for (i = 0; i < VELEM(8); i++) { QdV[i]=QsV[i] ^ QtV[i] ; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

<code>Qd4.b=vshufffe(Qs4.h,Qt4.h)</code>	<code>HVX_VectorPred Q6_Qb_vshufffe_QhQh(HVX_VectorPred Qs, HVX_VectorPred Qt)</code>
<code>Qd4.h=vshufffe(Qs4.w,Qt4.w)</code>	<code>HVX_VectorPred Q6_Qh_vshufffe_QwQw(HVX_VectorPred Qs, HVX_VectorPred Qt)</code>
<code>Qd4=and(Qs4, !Qt4)</code>	<code>HVX_VectorPred Q6_Q_and_QQn(HVX_VectorPred Qs, HVX_VectorPred Qt)</code>
<code>Qd4=and(Qs4, Qt4)</code>	<code>HVX_VectorPred Q6_Q_and_QQ(HVX_VectorPred Qs, HVX_VectorPred Qt)</code>

Qd4=or(Qs4,!Qt4)	HVX_VectorPred Q6_Q_or_QQn (HVX_VectorPred Qs, HVX_VectorPred Qt)
Qd4=or(Qs4,Qt4)	HVX_VectorPred Q6_Q_or_QQ (HVX_VectorPred Qs, HVX_VectorPred Qt)
Qd4=xor(Qs4,Qt4)	HVX_VectorPred Q6_Q_xor_QQ (HVX_VectorPred Qs, HVX_VectorPred Qt)

Encoding

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	
ICLASS								t2						Parse				s2				d2										
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	0	0	0	d	d	Qd4=and(Qs4,Qt4)
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	0	0	1	d	d	Qd4=or(Qs4,Qt4)
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	0	1	1	d	d	Qd4=xor(Qs4,Qt4)
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	1	0	0	d	d	Qd4=or(Qs4,!Qt4)
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	1	0	1	d	d	Qd4=and(Qs4,!Qt4)
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	1	1	0	d	d	Qd4.b=vshuffe(Qs4.h,Qt4.h)
0	0	0	1	1	1	1	0	t	t	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	1	1	1	d	d	Qd4.h=vshuffe(Qs4.w,Qt4.w)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d2	Field to encode register d
s2	Field to encode register s
t2	Field to encode register t

Combine

Combine two input vector registers into a single destination vector register pair.

Using a scalar predicate, conditionally copy a single vector register to a destination vector register, or conditionally combine two input vectors into a destination vector register pair. A scalar predicate guards the entire operation. If the scalar predicate is true, perform the operation. Otherwise the instruction is treated as a NOP.

Syntax	Behavior
<code>Vdd=vcombine (Vu,Vv)</code>	<pre>for (i = 0; i < VELEM(8); i++) { Vdd.v[0].ub[i] = Vv.ub[i]; Vdd.v[1].ub[i] = Vu.ub[i]; }</pre>
<code>if ([!]Ps) Vdd=vcombine (Vu,Vv)</code>	<pre>if ([!]Ps[0]) { for (i = 0; i < VELEM(8); i++) { Vdd.v[0].ub[i] = Vv.ub[i]; Vdd.v[1].ub[i] = Vu.ub[i]; } } else { NOP; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

`Vdd=vcombine (Vu,Vv)`

`HVX_VectorPair Q6_W_vcombine_VV(HVX_Vector Vu, HVX_Vector Vv)`

Encoding

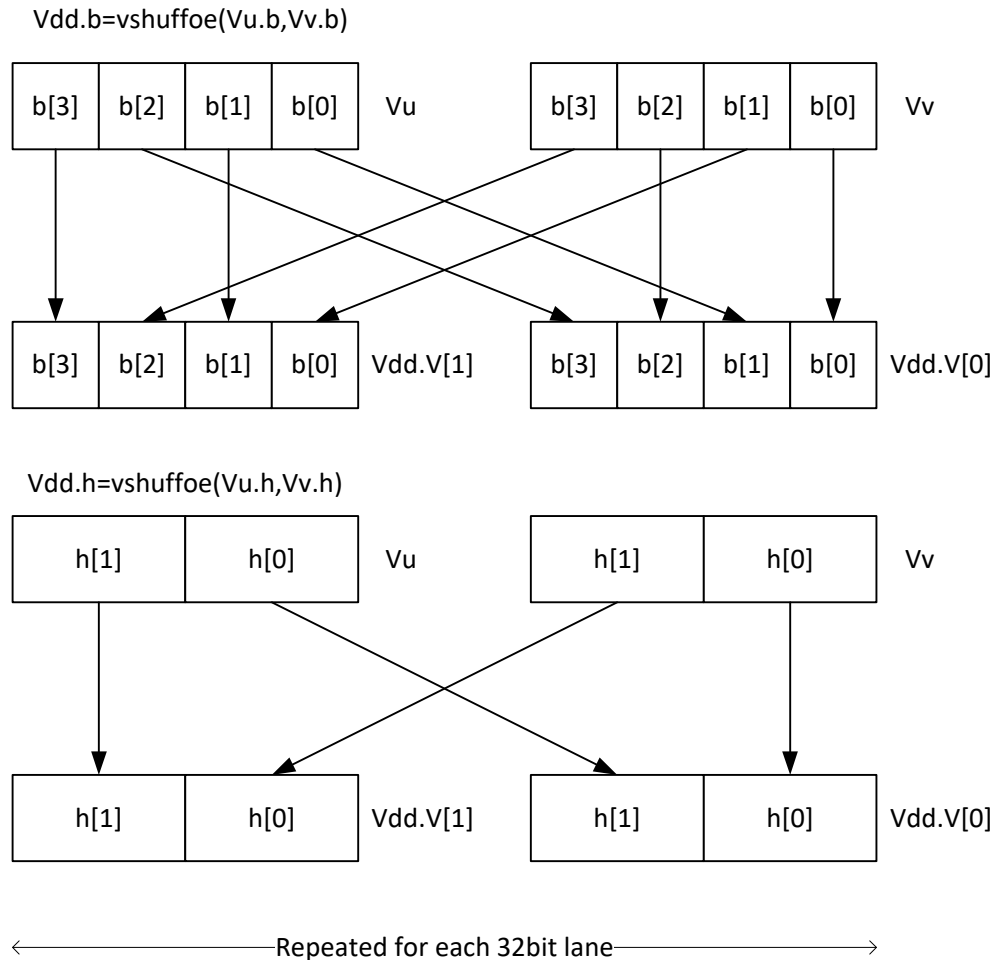
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					s2		d5							
0	0	0	1	1	0	1	0	0	1	0	v	v	v	v	v	P	P	-	u	u	u	u	u	-	s	s	d	d	d	d	d	if (!Ps) Vdd=vcombine(Vu,Vv)
0	0	0	1	1	0	1	0	0	1	1	v	v	v	v	v	P	P	-	u	u	u	u	u	-	s	s	d	d	d	d	d	if (Ps) Vdd=vcombine(Vu,Vv)
ICLASS																Parse		u5							d5							
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd=vcombine(Vu,Vv)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d

Field name	Description
s2	Field to encode register s
u5	Field to encode register u
v5	Field to encode register v

In-lane shuffle

`vshuffoe` performs both the `vshuffo` and `vshuffe` operation at the same time, with even elements placed into the even vector register of `Vdd`, and odd elements placed in the odd vector register of the destination vector pair.



This group of shuffles is limited to bytes and halfwords.

Syntax

`Vdd.b = vshuffoe(Vu.b, Vv.b)`

`Vdd.h = vshuffoe(Vu.h, Vv.h)`

Behavior

```
for (i = 0; i < VELEM(16); i++) {
  Vdd.v[0].uh[i].b[0] = Vv.uh[i].ub[0];
  Vdd.v[0].uh[i].b[1] = Vu.uh[i].ub[0];
  Vdd.v[1].uh[i].b[0] = Vv.uh[i].ub[1];
  Vdd.v[1].uh[i].b[1] = Vu.uh[i].ub[1];
}
```

```
for (i = 0; i < VELEM(32); i++) {
  Vdd.v[0].uw[i].h[0] = Vv.uw[i].uh[0];
  Vdd.v[0].uw[i].h[1] = Vu.uw[i].uh[0];
  Vdd.v[1].uw[i].h[0] = Vv.uw[i].uh[1];
  Vdd.v[1].uw[i].h[1] = Vu.uw[i].uh[1];
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

Vdd.b=vshuffoe(Vu.b,Vv.b)

HVX_VectorPair Q6_Wb_vshuffoe_VbVb(HVX_Vector Vu, HVX_Vector Vv)

Vdd.h=vshuffoe(Vu.h,Vv.h)

HVX_VectorPair Q6_Wh_vshuffoe_VhVh(HVX_Vector Vu, HVX_Vector Vv)

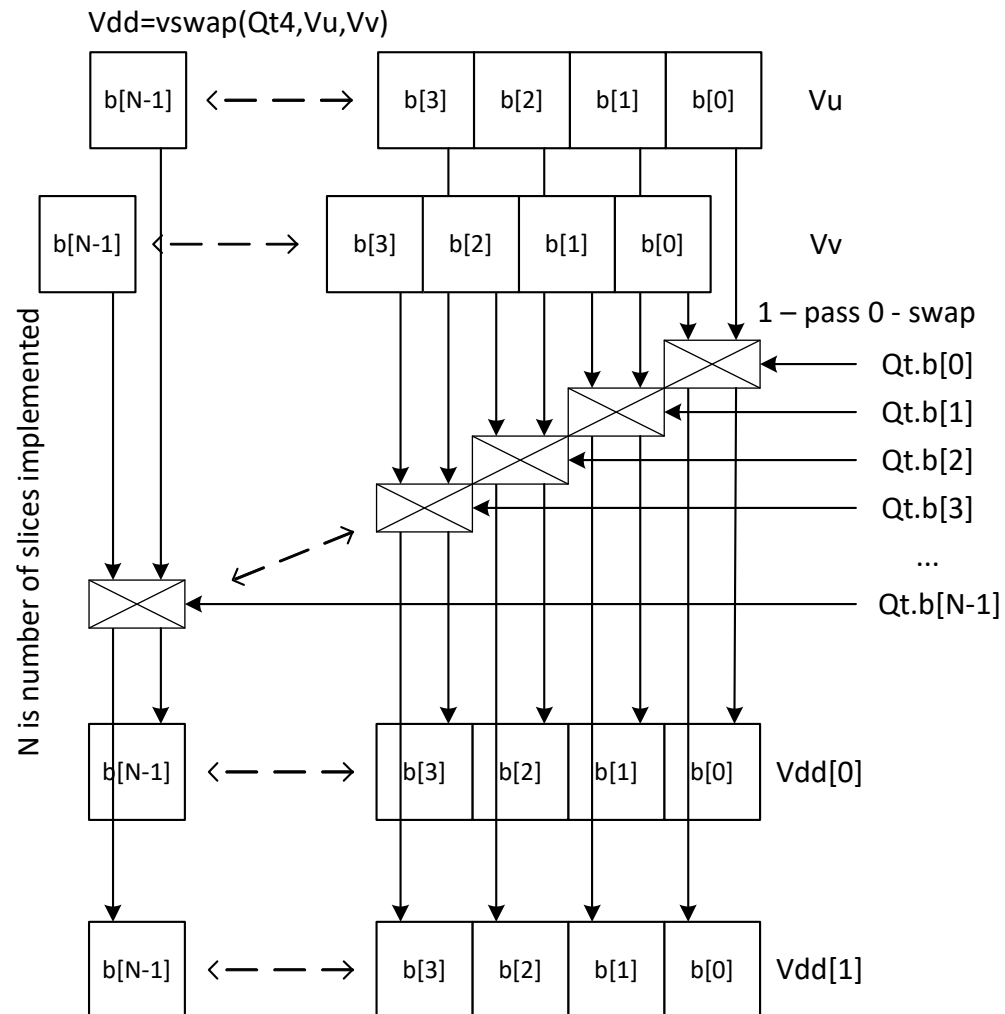
Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.h=vshuffoe(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.b=vshuffoe(Vu.b,Vv.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Swap

Based on a predicate bit in a vector predicate register, if the bit is set, place the corresponding byte from vector register Vu in the even destination vector register of Vdd , and place the byte from Vv in the odd destination vector register of Vdd . Otherwise, write the corresponding byte from Vv to the even register, and Vu to the odd register. The operation works on bytes so it can handle all data sizes. It is similar to the `vmux` operation, but places the opposite case output into the odd vector register of the destination vector register pair.



Syntax

```
Vdd=vswap(Qt4, Vu, Vv)
```

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vdd.v[0].ub[i] = QtV[i] ? Vu.ub[i] :
    Vv.ub[i];
    Vdd.v[1].ub[i] = !QtV[i] ? Vu.ub[i] :
    Vv.ub[i];
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

Vdd=vswap(Qt4, Vu, Vv)

```
HVX_VectorPair Q6_W_vswap_QVV(HVX_VectorPred Qt,
HVX_Vector Vu, HVX_Vector Vv)
```

Encoding

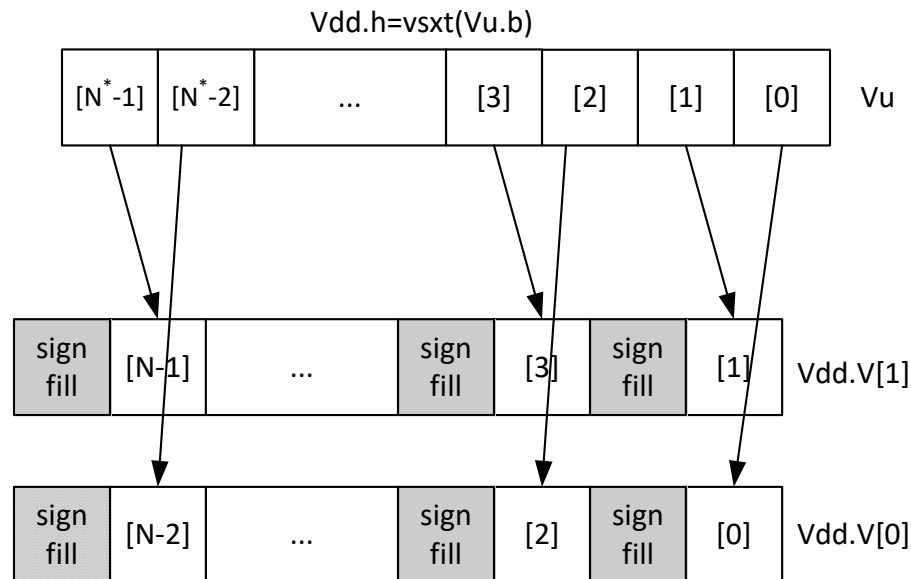
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					t2		d5							
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	-	t	t	d	d	d	d	d	Vdd=vswap(Qt4,Vu,Vv)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t2	Field to encode register t
u5	Field to encode register u
v5	Field to encode register v

Sign/Zero extension

Perform sign extension on each even element in V_u , and place it in the even destination vector register $V_{dd}[0]$. Sign-extend odd elements and place them in the odd destination vector register $V_{dd}[1]$. Bytes are converted to halfwords, and halfwords are converted to words.

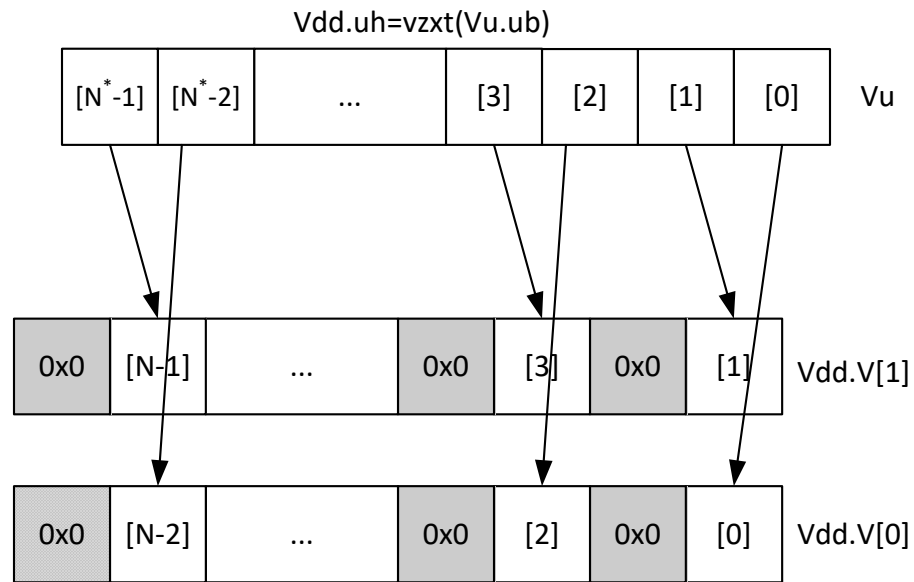
Sign extension of words is a cross-lane operation, and only executes on the permute slot.



*N is number of operations in vector

Perform zero extension on each even element in V_u , and place it in the even destination vector register $V_{dd}[0]$. Odd elements are zero-extended and placed in the odd destination vector register $V_{dd}[1]$. Bytes are converted to halfwords, and halfwords are converted to words.

Zero extension of words is a cross-lane operation, and only executes on the permute slot.



*N is number of operations in vector

Syntax

Vdd.h=vsxt (Vu.b)

Vdd.uh=vzxt (Vu.ub)

Vdd.uw=vzxt (Vu.uh)

Vdd.w=vsxt (Vu.h)

Vdd=vsxtb (Vu)

Vdd=vsxth (Vu)

Vdd=vzxtb (Vu)

Vdd=vzxth (Vu)

Behavior

```
for (i = 0; i < VELEM(16); i++) {
  Vdd.v[0].h[i] = Vu.h[i].b[0];
  Vdd.v[1].h[i] = Vu.h[i].b[1];
}
```

```
for (i = 0; i < VELEM(16); i++) {
  Vdd.v[0].uh[i] = Vu.uh[i].ub[0];
  Vdd.v[1].uh[i] = Vu.uh[i].ub[1];
}
```

```
for (i = 0; i < VELEM(32); i++) {
  Vdd.v[0].uw[i] = Vu.uw[i].uh[0];
  Vdd.v[1].uw[i] = Vu.uw[i].uh[1];
}
```

```
for (i = 0; i < VELEM(32); i++) {
  Vdd.v[0].w[i] = Vu.w[i].h[0];
  Vdd.v[1].w[i] = Vu.w[i].h[1];
}
```

Assembler mapped to: "Vdd.h=vsxt (Vu.b) "

Assembler mapped to: "Vdd.w=vsxt (Vu.h) "

Assembler mapped to: "Vdd.uh=vzxt (Vu.ub) "

Assembler mapped to: "Vdd.uw=vzxt (Vu.uh) "

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

Vdd.h=vsxt (Vu.b)	HVX_VectorPair Q6_Wh_vsxt_Vb (HVX_Vector Vu)
Vdd.uh=vzxt (Vu.ub)	HVX_VectorPair Q6_Wuh_vzxt_Vub (HVX_Vector Vu)
Vdd.uw=vzxt (Vu.uh)	HVX_VectorPair Q6_Wuw_vzxt_Vuh (HVX_Vector Vu)
Vdd.w=vsxt (Vu.h)	HVX_VectorPair Q6_Ww_vsxt_Vh (HVX_Vector Vu)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vdd.uh=vzxt(Vu.ub)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vdd.uw=vzxt(Vu.uh)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd.h=vsxt(Vu.b)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.w=vsxt(Vu.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u

Arithmetic

Perform simple arithmetic operations, add and subtract, between the elements of the two vectors Vu and Vv. Supports word, halfword (signed and unsigned), and byte (signed and unsigned).

Optionally saturate for word and halfword. Always saturate for unsigned types.

Syntax	Behavior
Vdd.b=vadd(Vuu.b,Vvv.b)[:sat]	<pre>for (i = 0; i < VELEM(8); i++) { Vdd.v[0].b[i] = [sat_8](Vuu.v[0].b[i]+Vvv.v[0].b[i]); Vdd.v[1].b[i] = [sat_8](Vuu.v[1].b[i]+Vvv.v[1].b[i]); }</pre>
Vdd.b=vsub(Vuu.b,Vvv.b)[:sat]	<pre>for (i = 0; i < VELEM(8); i++) { Vdd.v[0].b[i] = [sat_8](Vuu.v[0].b[i]- Vvv.v[0].b[i]); Vdd.v[1].b[i] = [sat_8](Vuu.v[1].b[i]- Vvv.v[1].b[i]); }</pre>
Vdd.h=vadd(Vuu.h,Vvv.h)[:sat]	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].h[i] = [sat_16](Vuu.v[0].h[i]+Vvv.v[0].h[i]); Vdd.v[1].h[i] = [sat_16](Vuu.v[1].h[i]+Vvv.v[1].h[i]); }</pre>
Vdd.h=vsub(Vuu.h,Vvv.h)[:sat]	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].h[i] = [sat_16](Vuu.v[0].h[i]- Vvv.v[0].h[i]); Vdd.v[1].h[i] = [sat_16](Vuu.v[1].h[i]- Vvv.v[1].h[i]); }</pre>
Vdd.ub=vadd(Vuu.ub,Vvv.ub):sat	<pre>for (i = 0; i < VELEM(8); i++) { Vdd.v[0].ub[i] = usat_8(Vuu.v[0].ub[i]+Vvv.v[0].ub[i]); Vdd.v[1].ub[i] = usat_8(Vuu.v[1].ub[i]+Vvv.v[1].ub[i]); }</pre>
Vdd.ub=vsub(Vuu.ub,Vvv.ub):sat	<pre>for (i = 0; i < VELEM(8); i++) { Vdd.v[0].ub[i] = usat_8(Vuu.v[0].ub[i]- Vvv.v[0].ub[i]); Vdd.v[1].ub[i] = usat_8(Vuu.v[1].ub[i]- Vvv.v[1].ub[i]); }</pre>
Vdd.uh=vadd(Vuu.uh,Vvv.uh):sat	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].uh[i] = usat_16(Vuu.v[0].uh[i]+Vvv.v[0].uh[i]); Vdd.v[1].uh[i] = usat_16(Vuu.v[1].uh[i]+Vvv.v[1].uh[i]); }</pre>

Syntax	Behavior
<code>Vdd.uh=vsub(Vuu.uh,Vvv.uh):sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].uh[i] = usat_16(Vuu.v[0].uh[i] - Vvv.v[0].uh[i]); Vdd.v[1].uh[i] = usat_16(Vuu.v[1].uh[i] - Vvv.v[1].uh[i]); }</pre>
<code>Vdd.uw=vadd(Vuu.uw,Vvv.uw):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].uw[i] = usat_32(Vuu.v[0].uw[i]+Vvv.v[0].uw[i]); Vdd.v[1].uw[i] = usat_32(Vuu.v[1].uw[i]+Vvv.v[1].uw[i]); }</pre>
<code>Vdd.uw=vsub(Vuu.uw,Vvv.uw):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].uw[i] = usat_32(Vuu.v[0].uw[i] - Vvv.v[0].uw[i]); Vdd.v[1].uw[i] = usat_32(Vuu.v[1].uw[i] - Vvv.v[1].uw[i]); }</pre>
<code>Vdd.w=vadd(Vuu.w,Vvv.w)[:sat]</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = [sat_32](Vuu.v[0].w[i]+Vvv.v[0].w[i]); Vdd.v[1].w[i] = [sat_32](Vuu.v[1].w[i]+Vvv.v[1].w[i]); }</pre>
<code>Vdd.w=vsub(Vuu.w,Vvv.w)[:sat]</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = [sat_32](Vuu.v[0].w[i] - Vvv.v[0].w[i]); Vdd.v[1].w[i] = [sat_32](Vuu.v[1].w[i] - Vvv.v[1].w[i]); }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

<code>Vdd.b=vadd(Vuu.b,Vvv.b)</code>	<code>HVX_VectorPair Q6_Wb_vadd_WbWb(HVX_VectorPair Vuu, HVX_VectorPair Vvv)</code>
<code>Vdd.b=vadd(Vuu.b,Vvv.b):sat</code>	<code>HVX_VectorPair Q6_Wb_vadd_WbWb_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)</code>
<code>Vdd.b=vsub(Vuu.b,Vvv.b)</code>	<code>HVX_VectorPair Q6_Wb_vsub_WbWb(HVX_VectorPair Vuu, HVX_VectorPair Vvv)</code>
<code>Vdd.b=vsub(Vuu.b,Vvv.b):sat</code>	<code>HVX_VectorPair Q6_Wb_vsub_WbWb_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)</code>
<code>Vdd.h=vadd(Vuu.h,Vvv.h)</code>	<code>HVX_VectorPair Q6_Wh_vadd_WhWh(HVX_VectorPair Vuu, HVX_VectorPair Vvv)</code>

Vdd.h=vadd(Vuu.h,Vvv.h):sat	HVX_VectorPair Q6_Wh_vadd_WhWh_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.h=vsub(Vuu.h,Vvv.h)	HVX_VectorPair Q6_Wh_vsub_WhWh(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.h=vsub(Vuu.h,Vvv.h):sat	HVX_VectorPair Q6_Wh_vsub_WhWh_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.ub=vadd(Vuu.ub,Vvv.ub):sat	HVX_VectorPair Q6_Wub_vadd_WubWub_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.ub=vsub(Vuu.ub,Vvv.ub):sat	HVX_VectorPair Q6_Wub_vsub_WubWub_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.uh=vadd(Vuu.uh,Vvv.uh):sat	HVX_VectorPair Q6_Wuh_vadd_WuhWuh_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.uh=vsub(Vuu.uh,Vvv.uh):sat	HVX_VectorPair Q6_Wuh_vsub_WuhWuh_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.uw=vadd(Vuu.uw,Vvv.uw):sat	HVX_VectorPair Q6_Wuw_vadd_WuwWuw_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.uw=vsub(Vuu.uw,Vvv.uw):sat	HVX_VectorPair Q6_Wuw_vsub_WuwWuw_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.w=vadd(Vuu.w,Vvv.w)	HVX_VectorPair Q6_Ww_vadd_WwWw(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.w=vadd(Vuu.w,Vvv.w):sat	HVX_VectorPair Q6_Ww_vadd_WwWw_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.w=vsub(Vuu.w,Vvv.w)	HVX_VectorPair Q6_Ww_vsub_WwWw(HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.w=vsub(Vuu.w,Vvv.w):sat	HVX_VectorPair Q6_Ww_vsub_WwWw_sat(HVX_VectorPair Vuu, HVX_VectorPair Vvv)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.b=vadd(Vuu.b,Vvv.b)
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.h=vadd(Vuu.h,Vvv.h)
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.w=vadd(Vuu.w,Vvv.w)
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd.ub=vadd(Vuu.ub,Vvv.ub):sat
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.uh=vadd(Vuu.uh,Vvv.uh):sat
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vdd.h=vadd(Vuu.h,Vvv.h):sat
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vdd.w=vadd(Vuu.w,Vvv.w):sat
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd.b=vsub(Vuu.b,Vvv.b)

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	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.h=vsub(Vuu.h,Vvv.h)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.w=vsub(Vuu.w,Vvv.w)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.ub=vsub(Vuu.ub,Vvv.ub):sat
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd.uh=vsub(Vuu.uh,Vvv.uh):sat
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.h=vsub(Vuu.h,Vvv.h):sat
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vdd.w=vsub(Vuu.w,Vvv.w):sat
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.b=vadd(Vuu.b,Vvv.b):sat
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vdd.b=vsub(Vuu.b,Vvv.b):sat
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vdd.uw=vadd(Vuu.uw,Vvv.uw):sat
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd.uw=vsub(Vuu.uw,Vvv.uw):sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

6.3 HVX/ALU-RESOURCE

The HVX/ALU-RESOURCE instruction subclass includes ALU instructions that use a single HVX resource.

Predicate operations

Perform bitwise logical operation on a vector predicate register Qs, and place the result in Qd. This operation works on vectors with any element size.

The following combination is implemented: !Qs.

Syntax

```
Qd4=not(Qs4)
```

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    QdV[i]=!QsV[i];
}
```

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

```
Qd4=not(Qs4)
```

```
HVX_VectorPred Q6_Q_not_Q(HVX_VectorPred Qs)
```

Encoding

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	
ICLASS																Parse		s2				d2										
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	1	P	P	0	-	-	-	s	s	0	0	0	0	1	0	d	d	Qd4=not(Qs4)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d2	Field to encode register d
s2	Field to encode register s

Byte-conditional vector assign

If the bit in Qv is set, copy the byte. Otherwise, set the byte in the destination to zero.

Syntax

```
Vd=vand(!Qv4,Vu)
```

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vd.b[i] = (!QvV[i] ? Vu.b[i] : 0;
}
```

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

```
Vd=vand(!Qv4,Vu)
```

```
HVX_Vector Q6_V_vand_QnV(HVX_VectorPred Qv,
HVX_Vector Vu)
```

```
Vd=vand(Qv4,Vu)
```

```
HVX_Vector Q6_V_vand_QV(HVX_VectorPred Qv,
HVX_Vector Vu)
```

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	1	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd=vand(Qv4,Vu)
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	1	P	P	1	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd=vand(!Qv4,Vu)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v2	Field to encode register v

Min/max

Compare the respective elements of Vu and Vv, and return the maximum or minimum. The result is placed in the same position as the inputs.

Supports unsigned byte, signed and unsigned halfword, and signed word.

Syntax	Behavior
Vd.b=vmax(Vu.b,Vv.b)	for (i = 0; i < VELEM(8); i++) { Vd.b[i] = (Vu.b[i] > Vv.b[i]) ? Vu.b[i] : Vv.b[i]; }
Vd.b=vmin(Vu.b,Vv.b)	for (i = 0; i < VELEM(8); i++) { Vd.b[i] = (Vu.b[i] < Vv.b[i]) ? Vu.b[i] : Vv.b[i]; }
Vd.h=vmax(Vu.h,Vv.h)	for (i = 0; i < VELEM(16); i++) { Vd.h[i] = (Vu.h[i] > Vv.h[i]) ? Vu.h[i] : Vv.h[i]; }
Vd.h=vmin(Vu.h,Vv.h)	for (i = 0; i < VELEM(16); i++) { Vd.h[i] = (Vu.h[i] < Vv.h[i]) ? Vu.h[i] : Vv.h[i]; }
Vd.hf=vmax(Vu.hf,Vv.hf)	for (i = 0; i < VELEM(16); i++) { Vd.hf[i] = max(Vu.hf[i],Vv.hf[i]); }
Vd.hf=vmin(Vu.hf,Vv.hf)	for (i = 0; i < VELEM(16); i++) { Vd.hf[i] = min(Vu.hf[i],Vv.hf[i]); }
Vd.sf=vmax(Vu.sf,Vv.sf)	for (i = 0; i < VELEM(32); i++) { Vd.sf[i] = max(Vu.sf[i],Vv.sf[i]); }
Vd.sf=vmin(Vu.sf,Vv.sf)	for (i = 0; i < VELEM(32); i++) { Vd.sf[i] = min(Vu.sf[i],Vv.sf[i]); }
Vd.ub=vmax(Vu.ub,Vv.ub)	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = (Vu.ub[i] > Vv.ub[i]) ? Vu.ub[i] : Vv.ub[i]; }
Vd.ub=vmin(Vu.ub,Vv.ub)	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = (Vu.ub[i] < Vv.ub[i]) ? Vu.ub[i] : Vv.ub[i]; }
Vd.uh=vmax(Vu.uh,Vv.uh)	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = (Vu.uh[i] > Vv.uh[i]) ? Vu.uh[i] : Vv.uh[i]; }
Vd.uh=vmin(Vu.uh,Vv.uh)	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = (Vu.uh[i] < Vv.uh[i]) ? Vu.uh[i] : Vv.uh[i]; }

Syntax	Behavior
<code>Vd.w=vmax(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i] > Vv.w[i]) ? Vu.w[i] : Vv.w[i]; }</pre>
<code>Vd.w=vmin(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i] < Vv.w[i]) ? Vu.w[i] : Vv.w[i]; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

<code>Vd.b=vmax(Vu.b,Vv.b)</code>	<code>HVX_Vector Q6_Vb_vmax_VbVb(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.b=vmin(Vu.b,Vv.b)</code>	<code>HVX_Vector Q6_Vb_vmin_VbVb(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.h=vmax(Vu.h,Vv.h)</code>	<code>HVX_Vector Q6_Vh_vmax_VhVh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.h=vmin(Vu.h,Vv.h)</code>	<code>HVX_Vector Q6_Vh_vmin_VhVh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.hf=vmax(Vu.hf,Vv.hf)</code>	<code>HVX_Vector Q6_Vhf_vmax_VhfVhf(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.hf=vmin(Vu.hf,Vv.hf)</code>	<code>HVX_Vector Q6_Vhf_vmin_VhfVhf(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.sf=vmax(Vu.sf,Vv.sf)</code>	<code>HVX_Vector Q6_Vsf_vmax_VsfVsf(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.sf=vmin(Vu.sf,Vv.sf)</code>	<code>HVX_Vector Q6_Vsf_vmin_VsfVsf(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.ub=vmax(Vu.ub,Vv.ub)</code>	<code>HVX_Vector Q6_Vub_vmax_VubVub(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.ub=vmin(Vu.ub,Vv.ub)</code>	<code>HVX_Vector Q6_Vub_vmin_VubVub(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.uh=vmax(Vu.uh,Vv.uh)</code>	<code>HVX_Vector Q6_Vuh_vmax_VuhVuh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.uh=vmin(Vu.uh,Vv.uh)</code>	<code>HVX_Vector Q6_Vuh_vmin_VuhVuh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.w=vmax(Vu.w,Vv.w)</code>	<code>HVX_Vector Q6_Vw_vmax_VwVw(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.w=vmin(Vu.w,Vv.w)</code>	<code>HVX_Vector Q6_Vw_vmin_VwVw(HVX_Vector Vu, HVX_Vector Vv)</code>

Encoding

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	
ICLASS											Parse						u5					d5										
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.ub=vmin(Vu.ub,Vv.ub)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uh=vmin(Vu.uh,Vv.uh)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vmin(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.w=vmin(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.ub=vmax(Vu.ub,Vv.ub)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.uh=vmax(Vu.uh,Vv.uh)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.h=vmax(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vmax(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.b=vmin(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.b=vmax(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.sf=vmax(Vu.sf,Vv.sf)
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.sf=vmin(Vu.sf,Vv.sf)
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.hf=vmax(Vu.hf,Vv.hf)
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.hf=vmin(Vu.hf,Vv.hf)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Absolute value

Take the absolute value of the vector register elements. Supports signed halfword and word. Optionally saturate to deal with the maximum negative value overflow case.

Syntax

Vd.b=vabs(Vu.b)[:sat]

Vd.h=vabs(Vu.h)[:sat]

Vd.ub=vabs(Vu.b)

Vd.uh=vabs(Vu.h)

Vd.uw=vabs(Vu.w)

Vd.w=vabs(Vu.w)[:sat]

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vd.b[i] = [sat_8] (ABS(Vu.b[i]));
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = [sat_16] (ABS(Vu.h[i]));
}
```

Assembler mapped to: "Vd.b=vabs(Vu.b)"

Assembler mapped to: "Vd.h=vabs(Vu.h)"

Assembler mapped to: "Vd.w=vabs(Vu.w)"

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = [sat_32] (ABS(Vu.w[i]));
}
```

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

Vd.b=vabs(Vu.b)

HVX_Vector Q6_Vb_vabs_Vb(HVX_Vector Vu)

Vd.b=vabs(Vu.b):sat

HVX_Vector Q6_Vb_vabs_Vb_sat(HVX_Vector Vu)

Vd.h=vabs(Vu.h)

HVX_Vector Q6_Vh_vabs_Vh(HVX_Vector Vu)

Vd.h=vabs(Vu.h):sat

HVX_Vector Q6_Vh_vabs_Vh_sat(HVX_Vector Vu)

Vd.w=vabs(Vu.w)

HVX_Vector Q6_Vw_vabs_Vw(HVX_Vector Vu)

Vd.w=vabs(Vu.w):sat

HVX_Vector Q6_Vw_vabs_Vw_sat(HVX_Vector Vu)

Encoding

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	
ICLASS																Parse				u5				d5								
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.h=vabs(Vu.h)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.h=vabs(Vu.h):sat
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.w=vabs(Vu.w)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.w=vabs(Vu.w):sat
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.b=vabs(Vu.b)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.b=vabs(Vu.b):sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u

Arithmetic

Perform simple arithmetic operations, add and subtract, between the elements of the two vectors Vu and Vv. Supports unsigned and signed byte and halfword.

Optionally saturate for word and signed halfword. Always saturate for unsigned types except byte.

Syntax	Behavior
Vd.b=vadd(Vu.b,Vv.b)[:sat]	for (i = 0; i < VELEM(8); i++) { Vd.b[i] = [sat_8] (Vu.b[i]+Vv.b[i]); }
Vd.b=vsub(Vu.b,Vv.b)[:sat]	for (i = 0; i < VELEM(8); i++) { Vd.b[i] = [sat_8] (Vu.b[i]-Vv.b[i]); }
Vd.h=vadd(Vu.h,Vv.h)[:sat]	for (i = 0; i < VELEM(16); i++) { Vd.h[i] = [sat_16] (Vu.h[i]+Vv.h[i]); }
Vd.h=vsub(Vu.h,Vv.h)[:sat]	for (i = 0; i < VELEM(16); i++) { Vd.h[i] = [sat_16] (Vu.h[i]-Vv.h[i]); }
Vd.ub=vadd(Vu.ub,Vv.b):sat	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = usat_8 (Vu.ub[i] + Vv.b[i]); }
Vd.ub=vadd(Vu.ub,Vv.ub):sat	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = usat_8 (Vu.ub[i]+Vv.ub[i]); }
Vd.ub=vsub(Vu.ub,Vv.b):sat	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = usat_8 (Vu.ub[i] - Vv.b[i]) ; }
Vd.ub=vsub(Vu.ub,Vv.ub):sat	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = usat_8 (Vu.ub[i]-Vv.ub[i]); }
Vd.uh=vadd(Vu.uh,Vv.uh):sat	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = usat_16 (Vu.uh[i]+Vv.uh[i]); }
Vd.uh=vsub(Vu.uh,Vv.uh):sat	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = usat_16 (Vu.uh[i]-Vv.uh[i]); }
Vd.uw=vadd(Vu.uw,Vv.uw):sat	for (i = 0; i < VELEM(32); i++) { Vd.uw[i] = usat_32 (Vu.uw[i]+Vv.uw[i]); }
Vd.uw=vsub(Vu.uw,Vv.uw):sat	for (i = 0; i < VELEM(32); i++) { Vd.uw[i] = usat_32 (Vu.uw[i]-Vv.uw[i]); }
Vd.w=vadd(Vu.w,Vv.w)[:sat]	for (i = 0; i < VELEM(32); i++) { Vd.w[i] = [sat_32] (Vu.w[i]+Vv.w[i]); }
Vd.w=vsub(Vu.w,Vv.w)[:sat]	for (i = 0; i < VELEM(32); i++) { Vd.w[i] = [sat_32] (Vu.w[i]-Vv.w[i]); }

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction can use any HVX resource.

Intrinsics

Vd.b=vadd(Vu.b,Vv.b)	HVX_Vector Q6_Vb_vadd_VbVb(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vadd(Vu.b,Vv.b) : sat	HVX_Vector Q6_Vb_vadd_VbVb_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vsub(Vu.b,Vv.b)	HVX_Vector Q6_Vb_vsub_VbVb(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vsub(Vu.b,Vv.b) : sat	HVX_Vector Q6_Vb_vsub_VbVb_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vadd(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vadd_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vadd(Vu.h,Vv.h) : sat	HVX_Vector Q6_Vh_vadd_VhVh_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vsub(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vsub_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vsub(Vu.h,Vv.h) : sat	HVX_Vector Q6_Vh_vsub_VhVh_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vadd(Vu.ub,Vv.b) : sat	HVX_Vector Q6_Vub_vadd_VubVb_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vadd(Vu.ub,Vv.ub) : sat	HVX_Vector Q6_Vub_vadd_VubVub_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vsub(Vu.ub,Vv.b) : sat	HVX_Vector Q6_Vub_vsub_VubVb_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vsub(Vu.ub,Vv.ub) : sat	HVX_Vector Q6_Vub_vsub_VubVub_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.uh=vadd(Vu.uh,Vv.uh) : sat	HVX_Vector Q6_Vuh_vadd_VuhVuh_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.uh=vsub(Vu.uh,Vv.uh) : sat	HVX_Vector Q6_Vuh_vsub_VuhVuh_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.uw=vadd(Vu.uw,Vv.uw) : sat	HVX_Vector Q6_Vuw_vadd_VuwVuww_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.uw=vsub(Vu.uw,Vv.uw) : sat	HVX_Vector Q6_Vuw_vsub_VuwVuww_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vadd(Vu.w,Vv.w)	HVX_Vector Q6_Vw_vadd_VwVw(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vadd(Vu.w,Vv.w) : sat	HVX_Vector Q6_Vw_vadd_VwVw_sat(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vsub(Vu.w,Vv.w)	HVX_Vector Q6_Vw_vsub_VwVw(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vsub(Vu.w,Vv.w) : sat	HVX_Vector Q6_Vw_vsub_VwVw_sat(HVX_Vector Vu, HVX_Vector Vv)

Encoding

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	
ICLASS																	Parse		u5					d5								
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vadd(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.ub=vadd(Vu.ub,Vv.ub):sat
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uh=vadd(Vu.uh,Vv.uh):sat
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vadd(Vu.h,Vv.h):sat
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.w=vadd(Vu.w,Vv.w):sat
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.b=vsub(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.h=vsub(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.w=vsub(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.ub=vsub(Vu.ub,Vv.ub):sat
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.uh=vsub(Vu.uh,Vv.uh):sat
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.h=vsub(Vu.h,Vv.h):sat
0	0	0	1	1	1	0	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.w=vsub(Vu.w,Vv.w):sat
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.ub=vadd(Vu.ub,Vv.b):sat
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.ub=vsub(Vu.ub,Vv.b):sat
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vadd(Vu.b,Vv.b):sat
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.b=vsub(Vu.b,Vv.b):sat
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.uw=vadd(Vu.uw,Vv.uw):sat
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.b=vadd(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.h=vadd(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.uw=vsub(Vu.uw,Vv.uw):sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Arithmetic with carry bit

Perform simple arithmetic operations, add and subtract, between the word elements of the two vectors *Vu* and *Vv* and a carry-out bit.

Optionally saturate for word.

Syntax	Behavior
<code>Rdd=add(Rss,Rtt,Px):carry</code>	<pre> PREDUSE_TIMING; Rdd = Rss + Rtt + Px[0]; Px = carry_from_add(Rss,Rtt,Px[0]) ? 0xff : 0x00; </pre>
<code>Rdd=sub(Rss,Rtt,Px):carry</code>	<pre> PREDUSE_TIMING; Rdd = Rss + ~Rtt + Px[0]; Px = carry_from_add(Rss,~Rtt,Px[0]) ? 0xff : 0x00; </pre>
<code>Vd.w,Qe4=vadd(Vu.w,Vv.w):carry</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vd.w[i] = Vu.w[i]+Vv.w[i]; QeV[4*i+4-1:4*i] = - carry_from(Vu.w[i],Vv.w[i],0); } </pre>
<code>Vd.w,Qe4=vsub(Vu.w,Vv.w):carry</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vd.w[i] = Vu.w[i]+~Vv.w[i]+1; QeV[4*i+4-1:4*i] = - carry_from(Vu.w[i],~Vv.w[i],1); } </pre>
<code>Vd.w=vadd(Vu.w,Vv.w,Qs4):carry:sat</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vd.w[i] = sat_32(Vu.w[i]+Vv.w[i]+QsV[i*4]) ; } </pre>
<code>Vd.w=vadd(Vu.w,Vv.w,Qx4):carry</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vd.w[i] = Vu.w[i]+Vv.w[i]+QxV[i*4]; QxV[4*i+4-1:4*i] = - carry_from(Vu.w[i],Vv.w[i],QxV[i*4]); } </pre>
<code>Vd.w=vsub(Vu.w,Vv.w,Qx4):carry</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vd.w[i] = Vu.w[i]+~Vv.w[i]+QxV[i*4]; QxV[4*i+4-1:4*i] = - carry_from(Vu.w[i],~Vv.w[i],QxV[i*4]); } </pre>

Class: XTYPE (slots 2,3)

Notes

- This instruction can use any HVX resource.
- The predicate generated by this instruction cannot be used as a .new predicate, nor can it be automatically AND'd with another predicate.

Intrinsics

Vd.w=vadd(Vu.w,Vv.w,Qs4):carry:sat	HVX_Vector Q6_Vw_vadd_VwVwQ_carry_sat (HVX_Vector Vu, HVX_Vector Vv, HVX_VectorPred Qs)
Vd.w=vadd(Vu.w,Vv.w,Qx4):carry	HVX_Vector Q6_Vw_vadd_VwVwQ_carry (HVX_Vector Vu, HVX_Vector Vv, HVX_VectorPred* Qp)
Vd.w=vsub(Vu.w,Vv.w,Qx4):carry	HVX_Vector Q6_Vw_vsub_VwVwQ_carry (HVX_Vector Vu, HVX_Vector Vv, HVX_VectorPred* Qp)

Encoding

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	
ICLASS																Parse		u5					x2		d5							
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	x	x	d	d	d	d		Vd.w=vadd(Vu.w,Vv.w,Qx4):carry
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	x	x	d	d	d	d		Vd.w=vsub(Vu.w,Vv.w,Qx4):carry
ICLASS																Parse		u5					s2		d5							
0	0	0	1	1	1	0	1	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	s	s	d	d	d	d		Vd.w=vadd(Vu.w,Vv.w,Qs4):carry:sat
ICLASS																Parse		u5					e2		d5							
0	0	0	1	1	1	0	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	e	e	d	d	d	d		Vd.w,Qe4=vadd(Vu.w,Vv.w):carry
0	0	0	1	1	1	0	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	e	e	d	d	d	d		Vd.w,Qe4=vsub(Vu.w,Vv.w):carry
ICLASS			RegType		Maj		s5					Parse		t5					x2		d5											
1	1	0	0	0	0	1	0	1	1	0	s	s	s	s	s	P	P	-	t	t	t	t	t	-	x	x	d	d	d	d		Rdd=add(Rss,Rtt,Px):carry
1	1	0	0	0	0	1	0	1	1	1	s	s	s	s	s	P	P	-	t	t	t	t	t	-	x	x	d	d	d	d		Rdd=sub(Rss,Rtt,Px):carry

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
e2	Field to encode register e
s2	Field to encode register s
s5	Field to encode register s
t5	Field to encode register t
u5	Field to encode register u
v5	Field to encode register v
x2	Field to encode register x
Maj	Major opcode
Min	Minor opcode
RegType	Register type

Logical operations

Perform bitwise logical operations (AND, OR, XOR) between the two vector registers. In the case of vnot, invert the input register.

Syntax	Behavior
Vd=vand(Vu,Vv)	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = Vu.uh[i] & Vv.h[i] ; }
Vd=vnot(Vu)	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = ~Vu.uh[i] ; }
Vd=vor(Vu,Vv)	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = Vu.uh[i] Vv.h[i] ; }
Vd=vxor(Vu,Vv)	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = Vu.uh[i] ^ Vv.h[i] ; }

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

Vd=vand(Vu,Vv)	HVX_Vector Q6_V_vand_VV(HVX_Vector Vu, HVX_Vector Vv)
Vd=vnot(Vu)	HVX_Vector Q6_V_vnot_V(HVX_Vector Vu)
Vd=vor(Vu,Vv)	HVX_Vector Q6_V_vor_VV(HVX_Vector Vu, HVX_Vector Vv)
Vd=vxor(Vu,Vv)	HVX_Vector Q6_V_vxor_VV(HVX_Vector Vu, HVX_Vector Vv)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd=vand(Vu,Vv)
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd=vor(Vu,Vv)
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd=vxor(Vu,Vv)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd=vnot(Vu)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Copy

Copy a single input vector register to a new output vector register.

Using a scalar predicate, conditionally copy a single vector register to a destination vector register, or conditionally combine two input vectors into a destination vector register pair. A scalar predicate guards the entire operation. If the scalar predicate is true, perform the operation. Otherwise the instruction is treated as a NOP.

Syntax

Vd=Vu

if ([!]Ps) Vd=Vu

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i]=Vu.w[i];
}
```

```
if ([!]Ps[0]) {
    for (i = 0; i < VELEM(8); i++) {
        Vd.ub[i] = Vu.ub[i];
    }
} else {
    NOP;
}
```

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

Vd=Vu

HVX_Vector Q6_V_equals_V(HVX_Vector Vu)

Encoding

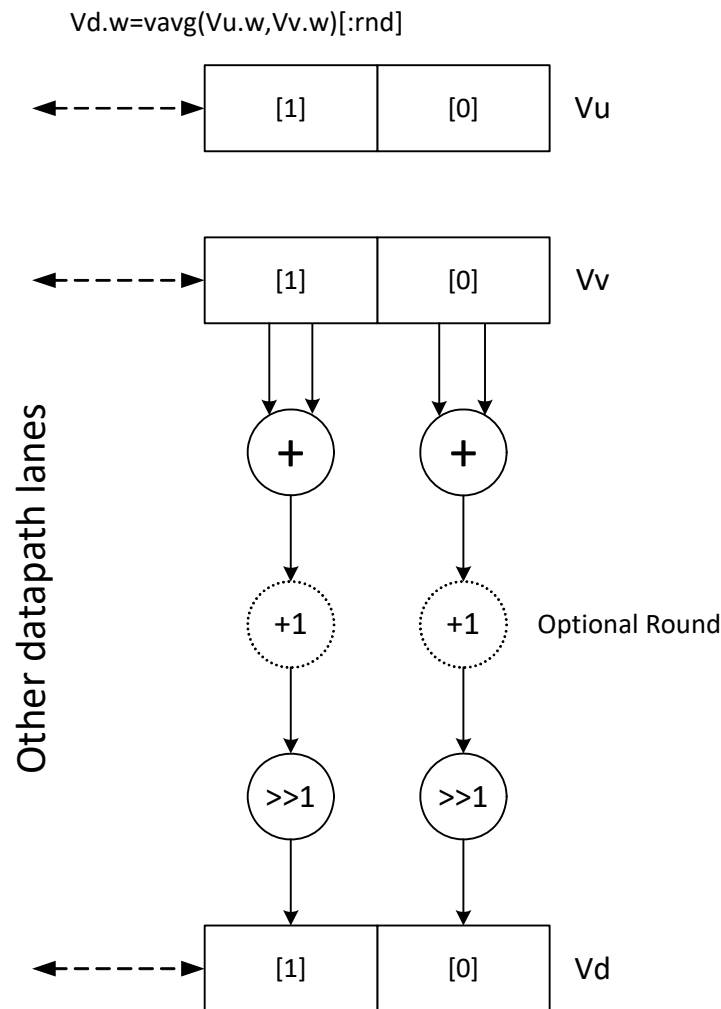
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					s2			d5						
0	0	0	1	1	0	1	0	0	0	0	-	-	-	-	-	P	P	-	u	u	u	u	u	-	s	s	d	d	d	d	d	if (Ps) Vd=Vu
0	0	0	1	1	0	1	0	0	0	1	-	-	-	-	-	P	P	-	u	u	u	u	u	-	s	s	d	d	d	d	d	if (!Ps) Vd=Vu
ICLASS																Parse		u5								d5						
0	0	0	1	1	1	1	0	-	-	0	-	-	0	1	1	P	P	1	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd=Vu

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
s2	Field to encode register s
u5	Field to encode register u

Average

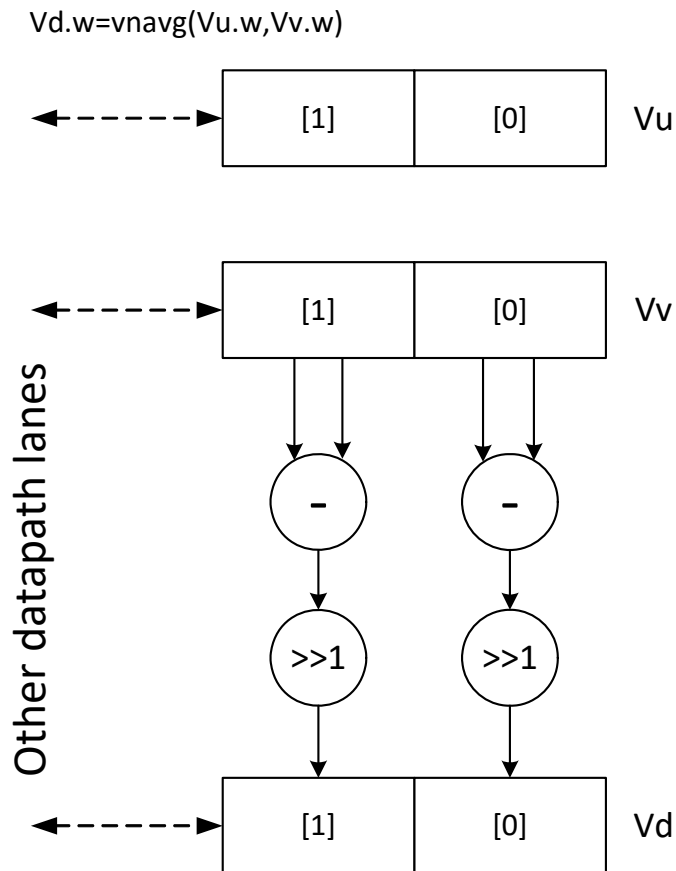
Add the elements of V_u to the respective elements of V_v , and shift the results right by one bit. The intermediate precision of the sum is larger than the input data precision. Optionally, a rounding constant $0x1$ is added before shifting.

Supports unsigned byte, signed and unsigned halfword, and signed word. The operation is replicated to fill the implemented data path width.



Subtract the elements of V_u from the respective elements of V_v , and shift the results right by 1 bit. The intermediate precision of the sum is larger than the input data precision. Saturate the data to the required precision.

Supports unsigned byte, halfword, and word. The operation is replicated to fill the implemented data path width.

**Syntax**
 $Vd.b = vavg(Vu.b, Vv.b) [:rnd]$
 $Vd.b = vnavg(Vu.b, Vv.b)$
 $Vd.b = vnavg(Vu.ub, Vv.ub)$
 $Vd.h = vavg(Vu.h, Vv.h) [:rnd]$
 $Vd.h = vnavg(Vu.h, Vv.h)$
 $Vd.ub = vavg(Vu.ub, Vv.ub) [:rnd]$
Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vd.b[i] = (Vu.b[i] + Vv.b[i+1]) / 2 ;
}
```

```
for (i = 0; i < VELEM(8); i++) {
    Vd.b[i] = (Vu.b[i] - Vv.b[i]) / 2 ;
}
```

```
for (i = 0; i < VELEM(8); i++) {
    Vd.b[i] = (Vu.ub[i] - Vv.ub[i]) / 2 ;
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = (Vu.h[i] + Vv.h[i+1]) / 2 ;
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = (Vu.h[i] - Vv.h[i]) / 2 ;
}
```

```
for (i = 0; i < VELEM(8); i++) {
    Vd.ub[i] = (Vu.ub[i] + Vv.ub[i+1]) / 2 ;
}
```


Syntax	Behavior
Vd.uh=vavg(Vu.uh,Vv.uh)[:rnd]	for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = (Vu.uh[i]+Vv.uh[i]+1)/2 ; }
Vd.uw=vavg(Vu.uw,Vv.uw)[:rnd]	for (i = 0; i < VELEM(32); i++) { Vd.uw[i] = (Vu.uw[i]+Vv.uw[i]+1)/2 ; }
Vd.w=vavg(Vu.w,Vv.w)[:rnd]	for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i]+Vv.w[i]+1)/2 ; }
Vd.w=vnavg(Vu.w,Vv.w)	for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i]-Vv.w[i])/2 ; }

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

Vd.b=vavg(Vu.b,Vv.b)	HVX_Vector Q6_Vb_vavg_VbVb(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vavg(Vu.b,Vv.b):rnd	HVX_Vector Q6_Vb_vavg_VbVb_rnd(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vnavg(Vu.b,Vv.b)	HVX_Vector Q6_Vb_vnavg_VbVb(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vnavg(Vu.ub,Vv.ub)	HVX_Vector Q6_Vb_vnavg_VubVub(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vavg(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vavg_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vavg(Vu.h,Vv.h):rnd	HVX_Vector Q6_Vh_vavg_VhVh_rnd(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vnavg(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vnavg_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vavg(Vu.ub,Vv.ub)	HVX_Vector Q6_Vub_vavg_VubVub(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vavg(Vu.ub,Vv.ub):rnd	HVX_Vector Q6_Vub_vavg_VubVub_rnd(HVX_Vector Vu, HVX_Vector Vv)
Vd.uh=vavg(Vu.uh,Vv.uh)	HVX_Vector Q6_Vuh_vavg_VuhVuh(HVX_Vector Vu, HVX_Vector Vv)
Vd.uh=vavg(Vu.uh,Vv.uh):rnd	HVX_Vector Q6_Vuh_vavg_VuhVuh_rnd(HVX_Vector Vu, HVX_Vector Vv)
Vd.uw=vavg(Vu.uw,Vv.uw)	HVX_Vector Q6_Vuw_vavg_VuwVuw(HVX_Vector Vu, HVX_Vector Vv)
Vd.uw=vavg(Vu.uw,Vv.uw):rnd	HVX_Vector Q6_Vuw_vavg_VuwVuw_rnd(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vavg(Vu.w,Vv.w)	HVX_Vector Q6_Vw_vavg_VwVw(HVX_Vector Vu, HVX_Vector Vv)

Vd.w=vavg(Vu.w,Vv.w):rnd

HVX_Vector Q6_Vw_vavg_VwVw_rnd(HVX_Vector Vu,
HVX_Vector Vv)

Vd.w=vnavg(Vu.w,Vv.w)

HVX_Vector Q6_Vw_vnavg_VwVw(HVX_Vector Vu,
HVX_Vector Vv)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.ub=vavg(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.uh=vavg(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.h=vavg(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.w=vavg(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vnavg(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.h=vnavg(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.w=vnavg(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.ub=vavg(Vu.ub,Vv.ub):rnd
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.uh=vavg(Vu.uh,Vv.uh):rnd
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.h=vavg(Vu.h,Vv.h):rnd
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.w=vavg(Vu.w,Vv.w):rnd
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uw=vavg(Vu.uw,Vv.uw)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.uw=vavg(Vu.uw,Vv.uw):rnd
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.b=vavg(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.b=vavg(Vu.b,Vv.b):rnd
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.b=vnavg(Vu.b,Vv.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Compare vectors

Perform compares between the two vector register inputs Vu and Vv. Depending on the element size, write an appropriate number of bits into the vector predicate register Qd for each pair of elements.

Two types of compare are supported: equal (.eq) and greater than (.gt).

Supports comparison of word, signed and unsigned halfword, signed and unsigned byte.

For each element comparison, the respective number of bits in the destination register are: bytes 1 bit, halfwords 2 bits, and words 4 bits.

Optionally supports XOR (^) with the destination, AND (&) with the destination, and OR (!) with the destination.

Syntax	Behavior
<code>Qd4=vcmp.eq(Vu.b,Vv.b)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QdV[i+1-1:i] = ((Vu.b[i/1] == Vv.b[i/1]) ? 0x1 : 0); }</pre>
<code>Qd4=vcmp.eq(Vu.h,Vv.h)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QdV[i+2-1:i] = ((Vu.h[i/2] == Vv.h[i/2]) ? 0x3 : 0); }</pre>
<code>Qd4=vcmp.eq(Vu.ub,Vv.ub)</code>	Assembler mapped to: " <code>Qd4=vcmp.eq(Vu." "b" " ,Vv." "b" ")"</code>
<code>Qd4=vcmp.eq(Vu.uh,Vv.uh)</code>	Assembler mapped to: " <code>Qd4=vcmp.eq(Vu." "h" " ,Vv." "h" ")"</code>
<code>Qd4=vcmp.eq(Vu.uw,Vv.uw)</code>	Assembler mapped to: " <code>Qd4=vcmp.eq(Vu." "w" " ,Vv." "w" ")"</code>
<code>Qd4=vcmp.eq(Vu.w,Vv.w)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QdV[i+4-1:i] = ((Vu.w[i/4] == Vv.w[i/4]) ? 0xF : 0); }</pre>
<code>Qd4=vcmp.gt(Vu.b,Vv.b)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QdV[i+1-1:i] = ((Vu.b[i/1] > Vv.b[i/1]) ? 0x1 : 0); }</pre>
<code>Qd4=vcmp.gt(Vu.h,Vv.h)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QdV[i+2-1:i] = ((Vu.h[i/2] > Vv.h[i/2]) ? 0x3 : 0); }</pre>
<code>Qd4=vcmp.gt(Vu.hf,Vv.hf)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { VAL = (Vu.hf[i/2] > Vv.hf[i/2]) ? 0x3 : 0 ; QdV[i+2-1:i] = VAL; }</pre>
<code>Qd4=vcmp.gt(Vu.sf,Vv.sf)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { VAL = (Vu.sf[i/4] > Vv.sf[i/4]) ? 0xF : 0 ; QdV[i+4-1:i] = VAL; }</pre>

Syntax	Behavior
<code>Qd4=vcmp.gt (Vu.ub, Vv.ub)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QdV[i+1-1:i] = ((Vu.ub[i/1] > Vv.ub[i/1]) ? 0x1 : 0); }</pre>
<code>Qd4=vcmp.gt (Vu.uh, Vv.uh)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QdV[i+2-1:i] = ((Vu.uh[i/2] > Vv.uh[i/2]) ? 0x3 : 0); }</pre>
<code>Qd4=vcmp.gt (Vu.uw, Vv.uw)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QdV[i+4-1:i] = ((Vu.uw[i/4] > Vv.uw[i/4]) ? 0xF : 0); }</pre>
<code>Qd4=vcmp.gt (Vu.w, Vv.w)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QdV[i+4-1:i] = ((Vu.w[i/4] > Vv.w[i/4]) ? 0xF : 0); }</pre>
<code>Qx4 [&] =vcmp.eq (Vu.b, Vv.b)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QxV[i+1-1:i] = QxV[i+1-1:i] [&] ((Vu.b[i/1] == Vv.b[i/1]) ? 0x1 : 0); }</pre>
<code>Qx4 [&] =vcmp.eq (Vu.h, Vv.h)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QxV[i+2-1:i] = QxV[i+2-1:i] [&] ((Vu.h[i/2] == Vv.h[i/2]) ? 0x3 : 0); }</pre>
<code>Qx4 [&] =vcmp.eq (Vu.ub, Vv.ub)</code>	Assembler mapped to: "Qx4 [&] =vcmp.eq (Vu." "b" ", Vv." "b" ")"
<code>Qx4 [&] =vcmp.eq (Vu.uh, Vv.uh)</code>	Assembler mapped to: "Qx4 [&] =vcmp.eq (Vu." "h" ", Vv." "h" ")"
<code>Qx4 [&] =vcmp.eq (Vu.uw, Vv.uw)</code>	Assembler mapped to: "Qx4 [&] =vcmp.eq (Vu." "w" ", Vv." "w" ")"
<code>Qx4 [&] =vcmp.eq (Vu.w, Vv.w)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QxV[i+4-1:i] = QxV[i+4-1:i] [&] ((Vu.w[i/4] == Vv.w[i/4]) ? 0xF : 0); }</pre>
<code>Qx4 [&] =vcmp.gt (Vu.b, Vv.b)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QxV[i+1-1:i] = QxV[i+1-1:i] [&] ((Vu.b[i/1] > Vv.b[i/1]) ? 0x1 : 0); }</pre>
<code>Qx4 [&] =vcmp.gt (Vu.h, Vv.h)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QxV[i+2-1:i] = QxV[i+2-1:i] [&] ((Vu.h[i/2] > Vv.h[i/2]) ? 0x3 : 0); }</pre>
<code>Qx4 [&] =vcmp.gt (Vu.hf, Vv.hf)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { VAL = (Vu.hf[i/2] > Vv.hf[i/2]) ? 0x3 : 0 ; QxV[i+2-1:i] = QxV[i+2-1:i] [&] VAL; }</pre>
<code>Qx4 [&] =vcmp.gt (Vu.sf, Vv.sf)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { VAL = (Vu.sf[i/4] > Vv.sf[i/4]) ? 0xF : 0 ; QxV[i+4-1:i] = QxV[i+4-1:i] [&] VAL; }</pre>
<code>Qx4 [&] =vcmp.gt (Vu.ub, Vv.ub)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QxV[i+1-1:i] = QxV[i+1-1:i] [&] ((Vu.ub[i/1] > Vv.ub[i/1]) ? 0x1 : 0); }</pre>

Syntax	Behavior
<code>Qx4 [&]=vcmp.gt (Vu.uh, Vv.uh)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QxV[i+2-1:i] = QxV[i+2-1:i] [&] ((Vu.uh[i/2] > Vv.uh[i/2]) ? 0x3 : 0); }</pre>
<code>Qx4 [&]=vcmp.gt (Vu.uw, Vv.uw)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QxV[i+4-1:i] = QxV[i+4-1:i] [&] ((Vu.uw[i/4] > Vv.uw[i/4]) ? 0xF : 0); }</pre>
<code>Qx4 [&]=vcmp.gt (Vu.w, Vv.w)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QxV[i+4-1:i] = QxV[i+4-1:i] [&] ((Vu.w[i/4] > Vv.w[i/4]) ? 0xF : 0); }</pre>
<code>Qx4^=vcmp.eq (Vu.b, Vv.b)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QxV[i+1-1:i] = QxV[i+1-1:i] ^ ((Vu.b[i/1] == Vv.b[i/1]) ? 0x1 : 0); }</pre>
<code>Qx4^=vcmp.eq (Vu.h, Vv.h)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QxV[i+2-1:i] = QxV[i+2-1:i] ^ ((Vu.h[i/2] == Vv.h[i/2]) ? 0x3 : 0); }</pre>
<code>Qx4^=vcmp.eq (Vu.ub, Vv.ub)</code>	Assembler mapped to: "Qx4^=vcmp.eq (Vu." "b" ",Vv." "b" ")"
<code>Qx4^=vcmp.eq (Vu.uh, Vv.uh)</code>	Assembler mapped to: "Qx4^=vcmp.eq (Vu." "h" ",Vv." "h" ")"
<code>Qx4^=vcmp.eq (Vu.uw, Vv.uw)</code>	Assembler mapped to: "Qx4^=vcmp.eq (Vu." "w" ",Vv." "w" ")"
<code>Qx4^=vcmp.eq (Vu.w, Vv.w)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QxV[i+4-1:i] = QxV[i+4-1:i] ^ ((Vu.w[i/4] == Vv.w[i/4]) ? 0xF : 0); }</pre>
<code>Qx4^=vcmp.gt (Vu.b, Vv.b)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QxV[i+1-1:i] = QxV[i+1-1:i] ^ ((Vu.b[i/1] > Vv.b[i/1]) ? 0x1 : 0); }</pre>
<code>Qx4^=vcmp.gt (Vu.h, Vv.h)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QxV[i+2-1:i] = QxV[i+2-1:i] ^ ((Vu.h[i/2] > Vv.h[i/2]) ? 0x3 : 0); }</pre>
<code>Qx4^=vcmp.gt (Vu.hf, Vv.hf)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { VAL = (Vu.hf[i/2] > Vv.hf[i/2]) ? 0x3 : 0 ; QxV[i+2-1:i] = QxV[i+2-1:i] ^ VAL; }</pre>
<code>Qx4^=vcmp.gt (Vu.sf, Vv.sf)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { VAL = (Vu.sf[i/4] > Vv.sf[i/4]) ? 0xF : 0 ; QxV[i+4-1:i] = QxV[i+4-1:i] ^ VAL; }</pre>
<code>Qx4^=vcmp.gt (Vu.ub, Vv.ub)</code>	<pre>for(i = 0; i < VWIDTH; i += 1) { QxV[i+1-1:i] = QxV[i+1-1:i] ^ ((Vu.ub[i/1] > Vv.ub[i/1]) ? 0x1 : 0); }</pre>
<code>Qx4^=vcmp.gt (Vu.uh, Vv.uh)</code>	<pre>for(i = 0; i < VWIDTH; i += 2) { QxV[i+2-1:i] = QxV[i+2-1:i] ^ ((Vu.uh[i/2] > Vv.uh[i/2]) ? 0x3 : 0); }</pre>

Syntax	Behavior
<code>Qx4^=vcmp.gt (Vu.uw, Vv.uw)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QxV[i+4-1:i] = QxV[i+4-1:i] ^ ((Vu.uw[i/4] > Vv.uw[i/4]) ? 0xF : 0); }</pre>
<code>Qx4^=vcmp.gt (Vu.w, Vv.w)</code>	<pre>for(i = 0; i < VWIDTH; i += 4) { QxV[i+4-1:i] = QxV[i+4-1:i] ^ ((Vu.w[i/4] > Vv.w[i/4]) ? 0xF : 0); }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

<code>Qd4=vcmp.eq (Vu.b, Vv.b)</code>	<code>HVX_VectorPred Q6_Q_vcmp_eq_VbVb (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.eq (Vu.h, Vv.h)</code>	<code>HVX_VectorPred Q6_Q_vcmp_eq_VhVh (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.eq (Vu.w, Vv.w)</code>	<code>HVX_VectorPred Q6_Q_vcmp_eq_VwVw (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.b, Vv.b)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VbVb (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.h, Vv.h)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VhVh (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.hf, Vv.hf)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VhfVhf (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.sf, Vv.sf)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VsfVsf (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.ub, Vv.ub)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VubVub (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.uh, Vv.uh)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VuhVuh (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.uw, Vv.uw)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VuwVuw (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qd4=vcmp.gt (Vu.w, Vv.w)</code>	<code>HVX_VectorPred Q6_Q_vcmp_gt_VwVw (HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qx4&=vcmp.eq (Vu.b, Vv.b)</code>	<code>HVX_VectorPred Q6_Q_vcmp_eqand_QVbVb (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qx4&=vcmp.eq (Vu.h, Vv.h)</code>	<code>HVX_VectorPred Q6_Q_vcmp_eqand_QVhVh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Qx4&=vcmp.eq (Vu.w, Vv.w)</code>	<code>HVX_VectorPred Q6_Q_vcmp_eqand_QVwVw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)</code>

<code>Qx4&=vcmp.gt (Vu.b, Vv.b)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVbVb (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.h, Vv.h)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVhVh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.hf, Vv.hf)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVhfVhf (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.sf, Vv.sf)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVsfVsf (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.ub, Vv.ub)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVubVub (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.uh, Vv.uh)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVuhVuh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.uw, Vv.uw)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVuwVuw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4&=vcmp.gt (Vu.w, Vv.w)</code>	HVX_VectorPred Q6_Q_vcmp_gtand_QVwVw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.eq (Vu.b, Vv.b)</code>	HVX_VectorPred Q6_Q_vcmp_eqxacc_QVbVb (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.eq (Vu.h, Vv.h)</code>	HVX_VectorPred Q6_Q_vcmp_eqxacc_QVhVh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.eq (Vu.w, Vv.w)</code>	HVX_VectorPred Q6_Q_vcmp_eqxacc_QVwVw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.b, Vv.b)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVbVb (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.h, Vv.h)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVhVh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.hf, Vv.hf)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVhfVhf (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.sf, Vv.sf)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVsfVsf (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.ub, Vv.ub)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVubVub (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.uh, Vv.uh)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVuhVuh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4^=vcmp.gt (Vu.uw, Vv.uw)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVuwVuw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)

<code>Qx4 ^=vcmp.gt (Vu.w, Vv.w)</code>	HVX_VectorPred Q6_Q_vcmp_gtxacc_QVwVw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.eq (Vu.b, Vv.b)</code>	HVX_VectorPred Q6_Q_vcmp_eqor_QVbVb (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.eq (Vu.h, Vv.h)</code>	HVX_VectorPred Q6_Q_vcmp_eqor_QVhVh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.eq (Vu.w, Vv.w)</code>	HVX_VectorPred Q6_Q_vcmp_eqor_QVwVw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.b, Vv.b)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVbVb (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.h, Vv.h)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVhVh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.hf, Vv.hf)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVhfVhf (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.sf, Vv.sf)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVsfVsf (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.ub, Vv.ub)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVubVub (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.uh, Vv.uh)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVuhVuh (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.uw, Vv.uw)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVuwVuw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)
<code>Qx4 =vcmp.gt (Vu.w, Vv.w)</code>	HVX_VectorPred Q6_Q_vcmp_gtor_QVwVw (HVX_VectorPred Qx, HVX_Vector Vu, HVX_Vector Vv)

Encoding

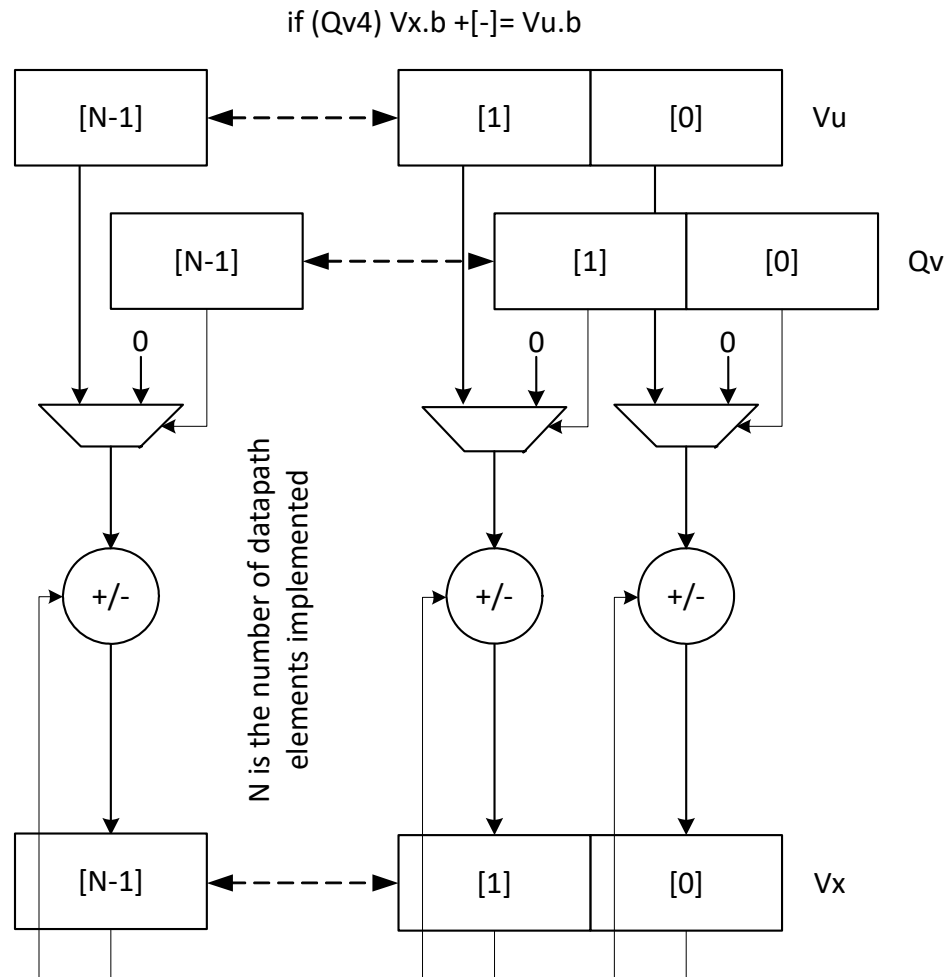
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					x2									
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	0	0	0	x	x	Qx4&=vcmp.eq(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	0	0	1	x	x	Qx4&=vcmp.eq(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	0	1	0	x	x	Qx4&=vcmp.eq(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	1	0	0	x	x	Qx4&=vcmp.gt(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	1	0	1	x	x	Qx4&=vcmp.gt(Vu.h,Vv.h)
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0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	0	0	0	x	x	Qx4&=vcmp.gt(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	0	0	1	x	x	Qx4&=vcmp.gt(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	0	1	0	x	x	Qx4&=vcmp.gt(Vu.uw,Vv.uw)

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	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	1	0	0	x	x	Qx4 =vcmp.gt(Vu.sf,Vv.sf)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	1	0	1	x	x	Qx4 =vcmp.gt(Vu.hf,Vv.hf)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	0	0	0	x	x	Qx4 =vcmp.eq(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	0	0	1	x	x	Qx4 =vcmp.eq(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	0	1	0	x	x	Qx4 =vcmp.eq(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	1	0	0	x	x	Qx4 =vcmp.gt(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	1	0	1	x	x	Qx4 =vcmp.gt(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	1	1	0	x	x	Qx4 =vcmp.gt(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	0	0	0	x	x	Qx4 =vcmp.gt(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	0	0	1	x	x	Qx4 =vcmp.gt(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	0	1	0	x	x	Qx4 =vcmp.gt(Vu.uw,Vv.uw)
ICLASS																		Parse			u5									d2		
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	1	0	0	d	d	Qd4=vcmp.gt(Vu.sf,Vv.sf)
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ICLASS																		Parse			u5									x2		
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	0	0	0	x	x	Qx4^=vcmp.eq(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	0	0	1	x	x	Qx4^=vcmp.eq(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	0	1	0	x	x	Qx4^=vcmp.eq(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	1	0	0	x	x	Qx4^=vcmp.gt(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	1	0	1	x	x	Qx4^=vcmp.gt(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	1	1	0	x	x	Qx4^=vcmp.gt(Vu.w,Vv.w)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	0	0	0	x	x	Qx4^=vcmp.gt(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	0	0	1	x	x	Qx4^=vcmp.gt(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	0	1	0	x	x	Qx4^=vcmp.gt(Vu.uw,Vv.uw)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	0	1	0	x	x	Qx4&=vcmp.gt(Vu.sf,Vv.sf)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	0	1	1	x	x	Qx4&=vcmp.gt(Vu.hf,Vv.hf)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	0	1	0	x	x	Qx4^=vcmp.gt(Vu.sf,Vv.sf)
0	0	0	1	1	1	0	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	0	1	1	x	x	Qx4^=vcmp.gt(Vu.hf,Vv.hf)
ICLASS																		Parse			u5									d2		
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	0	0	0	d	d	Qd4=vcmp.eq(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	0	0	1	d	d	Qd4=vcmp.eq(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	0	1	0	d	d	Qd4=vcmp.eq(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	1	0	0	d	d	Qd4=vcmp.gt(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	1	0	1	d	d	Qd4=vcmp.gt(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	1	1	0	d	d	Qd4=vcmp.gt(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	0	0	0	d	d	Qd4=vcmp.gt(Vu.ub,Vv.ub)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	0	0	1	d	d	Qd4=vcmp.gt(Vu.uh,Vv.uh)
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	0	1	0	d	d	Qd4=vcmp.gt(Vu.uw,Vv.uw)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d2	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x2	Field to encode register x

Conditional accumulate

Conditionally add or subtract a value to the destination register. If the corresponding bits are set in the vector predicate register, add to or subtract the elements in Vu from the corresponding elements in Vx. Supports byte, halfword, and word. No saturation is performed on the result.



Syntax

```
if ([!]Qv4) Vx.b[+/-]=Vu.b
```

```
if ([!]Qv4) Vx.h[+/-]=Vu.h
```

```
if ([!]Qv4) Vx.w[+/-]=Vu.w
```

Behavior

```
for (i = 0; i < VELEM(8); i[+/-][+/-]) {
    Vx.ub[i]=QvV.i ? Vx.ub[i] : Vx.ub[i][+/-]Vu.ub[i] ;
}
```

```
for (i = 0; i < VELEM(16); i[+/-][+/-]) {
    Vx.h[i]=select_bytes(QvV,i,Vx.h[i],Vx.h[i][+/-]Vu.h[i]) ;
}
```

```
for (i = 0; i < VELEM(32); i[+/-][+/-]) {
    Vx.w[i]=select_bytes(QvV,i,Vx.w[i],Vx.w[i][+/-]Vu.w[i]) ;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction can use any HVX resource.

Intrinsics

if (!Qv4) Vx.b+=Vu.b	HVX_Vector Q6_Vb_condacc_QnVbVb(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (!Qv4) Vx.b-=Vu.b	HVX_Vector Q6_Vb_condnac_QnVbVb(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (!Qv4) Vx.h+=Vu.h	HVX_Vector Q6_Vh_condacc_QnVhVh(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (!Qv4) Vx.h-=Vu.h	HVX_Vector Q6_Vh_condnac_QnVhVh(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (!Qv4) Vx.w+=Vu.w	HVX_Vector Q6_Vw_condacc_QnVwVw(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (!Qv4) Vx.w-=Vu.w	HVX_Vector Q6_Vw_condnac_QnVwVw(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (Qv4) Vx.b+=Vu.b	HVX_Vector Q6_Vb_condacc_QVbVb(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (Qv4) Vx.b-=Vu.b	HVX_Vector Q6_Vb_condnac_QVbVb(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (Qv4) Vx.h+=Vu.h	HVX_Vector Q6_Vh_condacc_QVhVh(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (Qv4) Vx.h-=Vu.h	HVX_Vector Q6_Vh_condnac_QVhVh(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (Qv4) Vx.w+=Vu.w	HVX_Vector Q6_Vw_condacc_QVwVw(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)
if (Qv4) Vx.w-=Vu.w	HVX_Vector Q6_Vw_condnac_QVwVw(HVX_VectorPred Qv, HVX_Vector Vx, HVX_Vector Vu)

Encoding

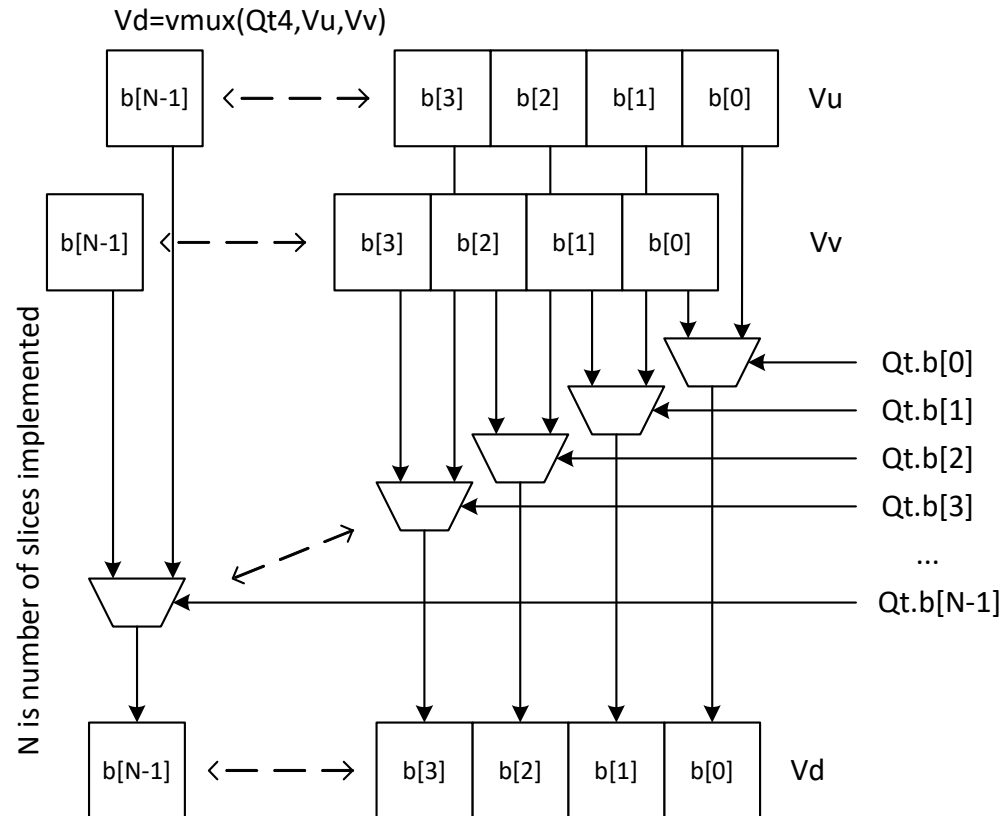
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	if (Qv4) Vx.b+=Vu.b
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	if (Qv4) Vx.h+=Vu.h
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	if (Qv4) Vx.w+=Vu.w
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	if (!Qv4) Vx.b+=Vu.b
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	if (!Qv4) Vx.h+=Vu.h
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	if (!Qv4) Vx.w+=Vu.w
0	0	0	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x	if (Qv4) Vx.b-=Vu.b

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	1	1	1	1	0	v	v	0	-	-	0	0	1	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	if (Qv4) Vx.h=Vu.h
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	if (Qv4) Vx.w=Vu.w
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	if (!Qv4) Vx.b=Vu.b
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	if (!Qv4) Vx.h=Vu.h
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	0	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	if (!Qv4) Vx.w=Vu.w

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
u5	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Mux select

Perform a parallel if-then-else operation. Based on a predicate bit in a vector predicate register, if the bit is set, place the corresponding byte from vector register Vu in the destination vector register Vd. Otherwise, write the corresponding byte from Vv. The operation works on bytes; it can handle all data sizes.



Syntax

```
Vd=vmux(Qt4, Vu, Vv)
```

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vd.ub[i] = QtV[i] ? Vu.ub[i] : Vv.ub[i];
}
```

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

```
Vd=vmux(Qt4, Vu, Vv)
```

```
HVX_Vector Q6_V_vmux_QVV(HVX_VectorPred Qt,
HVX_Vector Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					t2		d5							
0	0	0	1	1	1	1	0	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	-	t	t	d	d	d	d	d	Vd=vmux(Qt4,Vu,Vv)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t2	Field to encode register t
u5	Field to encode register u
v5	Field to encode register v

Saturation

Perform simple arithmetic operations, add and subtract, between the elements of the two vectors Vu and Vv. Supports word, halfword (signed and unsigned), and byte (signed and unsigned).

Optionally saturate for word and halfword. Always saturate for unsigned types.

Syntax	Behavior
Vd.h=vsat (Vu.w, Vv.w)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i].h[0]=sat_16(Vv.w[i]); Vd.w[i].h[1]=sat_16(Vu.w[i]); }</pre>
Vd.ub=vsat (Vu.h, Vv.h)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i].b[0]=usat_8(Vv.h[i]); Vd.uh[i].b[1]=usat_8(Vu.h[i]); }</pre>
Vd.uh=vsat (Vu.uw, Vv.uw)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i].h[0]=usat_16(Vv.uw[i]); Vd.w[i].h[1]=usat_16(Vu.uw[i]); }</pre>
Vd.w=vsatdw (Vu.w, Vv.w)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = usat_32 (Vu.w[i]:Vv.w[i]); }</pre>
Vd=vsathub (Vu, Vv)	Assembler mapped to: "Vd.ub=vsat (Vu.h, Vv.h) "
Vd=vsatuwuh (Vu, Vv)	Assembler mapped to: "Vd.uh=vsat (Vu.uw, Vv.uw) "
Vd=vsatwh (Vu, Vv)	Assembler mapped to: "Vd.h=vsat (Vu.w, Vv.w) "

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

Vd.h=vsat (Vu.w, Vv.w)	HVX_Vector Q6_Vh_vsat_VwVw (HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vsat (Vu.h, Vv.h)	HVX_Vector Q6_Vub_vsat_VhVh (HVX_Vector Vu, HVX_Vector Vv)
Vd.uh=vsat (Vu.uw, Vv.uw)	HVX_Vector Q6_Vuh_vsat_VuwVuw (HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vsatdw (Vu.w, Vv.w)	HVX_Vector Q6_Vw_vsatdw_VwVw (HVX_Vector Vu, HVX_Vector Vv)

Encoding

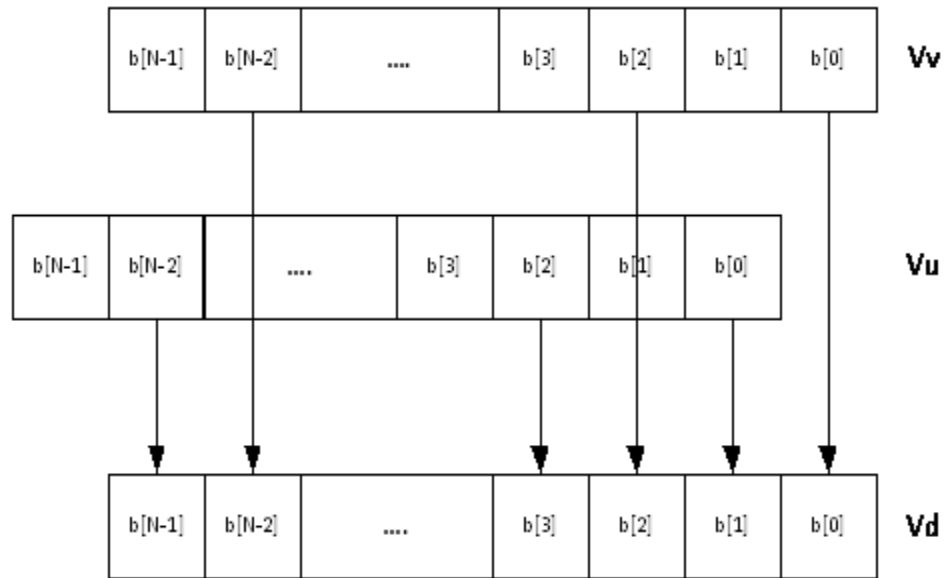
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																	Parse		u5					d5								
0	0	0	1	1	1	0	1	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.w=vsatdw(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.uh=vsat(Vu.uw,Vv.uw)
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.ub=vsat(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vsat(Vu.w,Vv.w)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

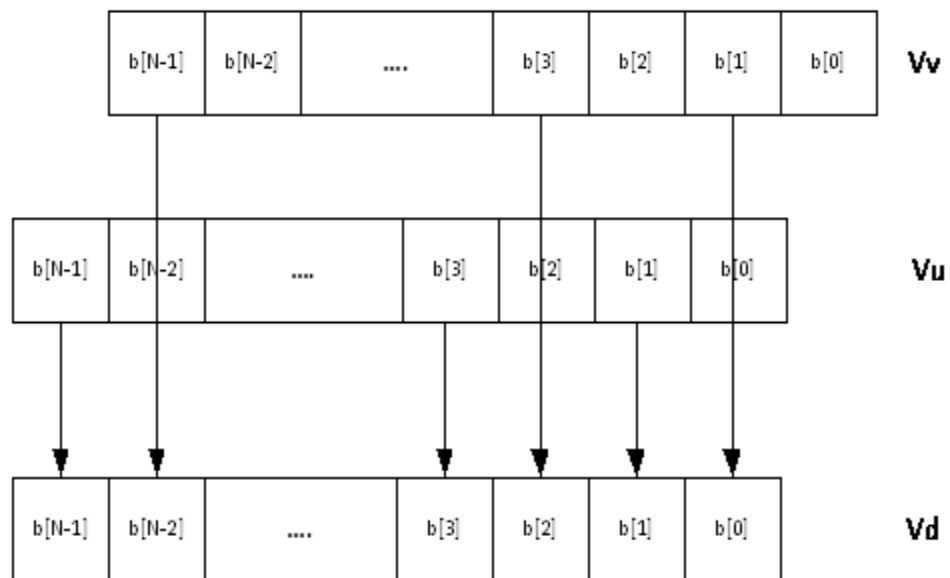
In-lane shuffle

Shuffle the even or odd elements respectively from two vector registers into one destination vector register. Supports bytes and halfwords.

Vd.b = vshuffe(Vu.b, Vv.b)



Vd.b = vshuffo(Vu.b, Vv.b)



This group of shuffles is limited to bytes and halfwords.

Syntax	Behavior
Vd.b=vshuffe(Vu.b,Vv.b)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i].b[0]=Vv.uh[i].ub[0]; Vd.uh[i].b[1]=Vu.uh[i].ub[0]; }</pre>
Vd.b=vshuffo(Vu.b,Vv.b)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i].b[0]=Vv.uh[i].ub[1]; Vd.uh[i].b[1]=Vu.uh[i].ub[1]; }</pre>
Vd.h=vshuffe(Vu.h,Vv.h)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i].h[0]=Vv.uw[i].uh[0]; Vd.uw[i].h[1]=Vu.uw[i].uh[0]; }</pre>
Vd.h=vshuffo(Vu.h,Vv.h)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i].h[0]=Vv.uw[i].uh[1]; Vd.uw[i].h[1]=Vu.uw[i].uh[1]; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction can use any HVX resource.

Intrinsics

Vd.b=vshuffe(Vu.b,Vv.b)	HVX_Vector Q6_Vb_vshuffe_VbVb(HVX_Vector Vu, HVX_Vector Vv)
Vd.b=vshuffo(Vu.b,Vv.b)	HVX_Vector Q6_Vb_vshuffo_VbVb(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vshuffe(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vshuffe_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vshuffo(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vshuffo_VhVh(HVX_Vector Vu, HVX_Vector Vv)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.b=vshuffe(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.b=vshuffo(Vu.b,Vv.b)
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vshuffe(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.h=vshuffo(Vu.h,Vv.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits

Field name	Description
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

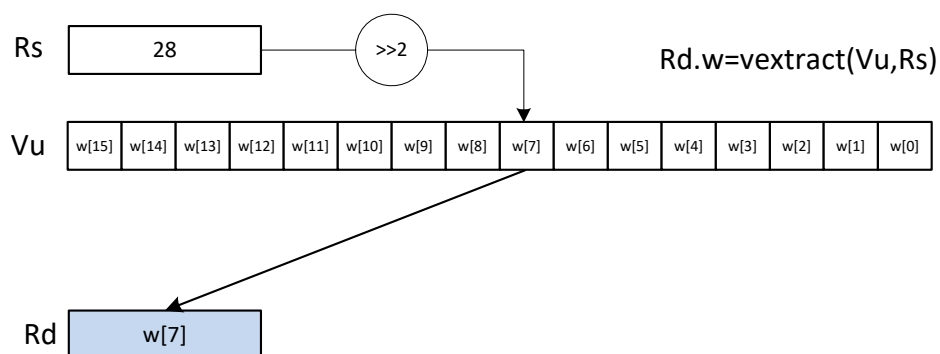
6.4 HVX/DEBUG

The HVX/DEBUG instruction subclass includes debugging instructions.

Extract vector element

Extract a word from the vector register Vu using bits 5:2 of Rs as the word index. The result is placed in the scalar register Rd. A memory address can be used as the control selection Rs after data has been read from memory using a vector load.

This is a very high latency instruction and should only be used in debug. A memory to memory transfer is more efficient.



Syntax

```
Rd.w=vextract (Vu, Rs)
```

```
Rd=vextract (Vu, Rs)
```

Behavior

Assembler mapped to: "Rd=vextract (Vu, Rs) "

```
Rd = Vu.uw[ (Rs & (VWIDTH-1)) >> 2];
```

Class: LD (slots 0)

Notes

- This is a solo instruction. It must not be grouped with other instructions in a packet.

Intrinsics

```
Rd=vextract (Vu, Rs)
```

```
Word32 Q6_R_vextract_VR(HVX_Vector Vu, Word32 Rs)
```

Encoding

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		
ICLASS				Amode				Type				UN	s5				Parse				u5				d5								
1	0	0	1	0	0	1	0	0	0	0	s	s	s	s	s	P	P	0	u	u	u	u	u	0	0	0	1	d	d	d	d	d	Rd=vextract(Vu,Rs)

Field name	Description
ICLASS	Instruction class
Amode	Amode
Type	Type
UN	Unsigned
Parse	Packet/loop parse bits
d5	Field to encode register d
s5	Field to encode register s
u5	Field to encode register u

6.5 HVX/GATHER-DOUBLE-RESOURCE

The HVX/GATHER-DOUBLE-RESOURCE instruction subclass includes instructions that perform gather operations into the vector TCM.

Vector gather

Gather operations are element copies from a large region in VTCM to a smaller vector-sized region. The larger region of memory is specified by two scalar registers: $Rt32$ is the base and $Mu2$ specified the length-1 of the region in bytes. This region must reside in VTCM and cannot cross a page boundary. A vector register, $Vv32$, specifies byte offsets to this region. Elements of halfword granularity are copied from the address pointed to by $Rt + Vv32$ for each element in the vector to the corresponding element in the linear element pointed to by the accompanying store.

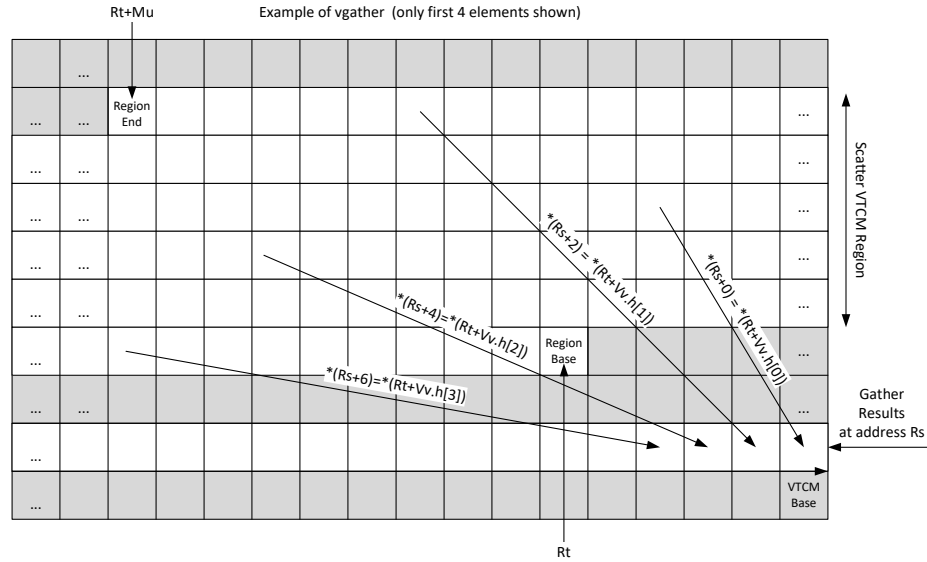
The offset vector, $Vv32$, can contain byte offsets specified in either halfword or word sizes. The final element addresses are not required to be byte aligned. An offset that crosses the end of the gather region is dropped. Offsets must be positive, otherwise they are dropped. A vector predicate register can also be specified. If the predicate is false, that byte is not copied. This can emulate a byte gather.

The gather instruction must be paired with a VMEM .new store that uses a temporary register source.

For example, `{VMEM(R0+#0) = Vtmp.new; Vtmp.h = vgather(R1,M0, V1:0.w);}` gathers halfwords with halfword addresses and saves the results to the address pointed to by R0 of the VMEM instruction. A vgather that is not accompanied with a store is dropped.

```
{ vmem(Rs+#l)=Vtmp.h; vtmp.h = vgather(Rt,Mu,Vv.h) }
```

Rs – Address of gathered values in VTCM **Rt** – Scalar Indicating base address in VTCM
Mu – Scalar indicating length-1 of Region
Vv – Vector with byte offsets from base



Syntax

```
if (Qs4)
vtmp.h=vgather (Rt, Mu, Vvv.w) .h
```

```
vtmp.h=vgather (Rt, Mu, Vvv.w) .h
```

Behavior

```
MuV = MuV | (element_size-1);
Rt = Rt & ~(element_size-1);
for (i = 0; i < VELEM(32); i++) {
    for(j = 0; j < 2; j++) {
        EA = Rt+Vvv.v[j].uw[i];
        if ( (Rt <= EA <= Rt + MuV) & QsV)
            TEMP.uw[i].uh[j] = *EA;
    }
}
```

```
MuV = MuV | (element_size-1);
Rt = Rt & ~(element_size-1);
for (i = 0; i < VELEM(32); i++) {
    for(j = 0; j < 2; j++) {
        EA = Rt+Vvv.v[j].uw[i];
        if (Rt <= EA <= Rt + MuV)
            TEMP.uw[i].uh[j] = *EA;
    }
}
```

Class: COPROC_VMEM (slots 0,1)

Notes

- This instruction can use any HVX resource.

Intrinsics

```
if (Qs4)
vtmp.h=vgather(Rt,Mu,Vvv.w).h
```

```
void Q6_vgather_AQRMWw(HVX_Vector* A,
HVX_VectorPred Qs, HVX_Vector* Rb, Word32 Mu,
HVX_VectorPair Vvv)
```

```
vtmp.h=vgather(Rt,Mu,Vvv.w).h
```

```
void Q6_vgather_ARMWw(HVX_Vector* A, HVX_Vector*
Rb, Word32 Mu, HVX_VectorPair Vvv)
```

Encoding

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	
ICLASS										NT	t5					Parse	u1															
0	0	1	0	1	1	1	1	0	0	0	t	t	t	t	t	P	P	u	-	-	0	1	0	-	-	-	v	v	v	v	v	vtmp.h=vgather(Rt,Mu,Vvv.w).h
ICLASS										NT	t5					Parse	u1	s2														
0	0	1	0	1	1	1	1	0	0	0	t	t	t	t	t	P	P	u	-	-	1	1	0	-	s	s	v	v	v	v	v	if (Qs4) vtmp.h=vgather(Rt,Mu,Vvv.w).h

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s2	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v5	Field to encode register v

6.6 HVX/GATHER

The HVX/GATHER instruction subclass includes instructions that perform gather operations.

Vector gather

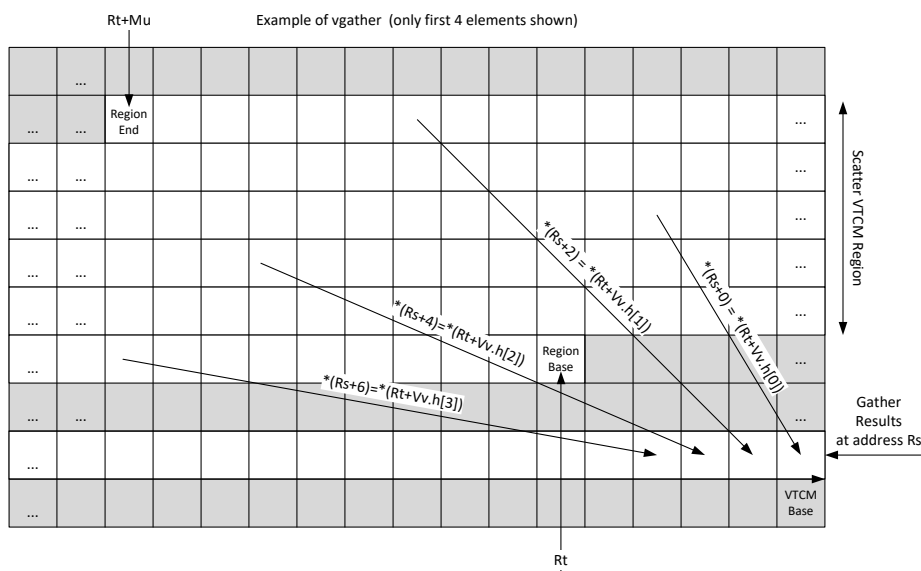
Vector gather instructions perform gather operations in the vector TCM. Gather operations are element copies from a large region in VTCM to a smaller vector-sized region. Two scalar registers specify the larger region of memory: Rt32 is the base and Mu2 specified the length-1 of the region in bytes. This region must reside in VTCM and cannot cross a page boundary. A vector register, Vv32, specifies byte offsets to this region. Elements of either halfword or word granularity are copied from the address pointed to by $Rt + Vv32$ for each element in the vector to the corresponding element in the linear element pointed to by the accompanying store.

The offset vector, Vv32, can contain byte offsets specified in either halfword or word sizes. The final element addresses are not required to be byte aligned. An offset that crosses the end of the gather region is dropped. Offsets must be positive otherwise, they are dropped. A vector predicate register can also be specified. If a the predicate is false, that byte is not copied. This emulates a byte gather.

The gather instruction must be paired with a VMEM .new store that uses a temporary register source. For example, `{VMEM(R0+#0) = Vtmp.new; Vtmp.h = vgather(R1,M0, V0.h);}` gathers halfwords with halfword addresses and saves the results to the address pointed to by R0 of the VMEM instruction. A vgather not accompanied with a store is dropped.

```
{ vmem(Rs+#l)=Vtmp.h; vtmp.h = vgather(Rt,Mu,Vv.h) }
```

Rs – Address of gathered values in VTCM Rt – Scalar Indicating base address in VTCM
Mu – Scalar indicating length-1 of Region
Vv – Vector with byte offsets from base



Syntax	Behavior
<pre>if (Qs4) vtmp.h=vgather (Rt,Mu,Vv.h) .h</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(16); i++) { EA = Rt+Vv.uh[i]; if ((Rt <= EA <= Rt + MuV) & QsV) TEMP.uh[i] = *EA; }</pre>
<pre>if (Qs4) vtmp.w=vgather (Rt,Mu,Vv.w) .w</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { EA = Rt+Vv.uw[i]; if ((Rt <= EA <= Rt + MuV) & QsV) TEMP.uw[i] = *EA; }</pre>
<pre>vtmp.h=vgather (Rt,Mu,Vv.h) .h</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(16); i++) { EA = Rt+Vv.uh[i]; if (Rt <= EA <= Rt + MuV) TEMP.uh[i] = *EA; }</pre>
<pre>vtmp.w=vgather (Rt,Mu,Vv.w) .w</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { EA = Rt+Vv.uw[i]; if (Rt <= EA <= Rt + MuV) TEMP.uw[i] = *EA; }</pre>

Class: COPROC_VMEM (slots 0,1)

Notes

- This instruction can use any HVX resource.

Intrinsics

<pre>if (Qs4) vtmp.h=vgather (Rt,Mu,Vv.h) .h</pre>	<pre>void Q6_vgather_AQRMVh(HVX_Vector* A, HVX_VectorPred Qs, HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv)</pre>
<pre>if (Qs4) vtmp.w=vgather (Rt,Mu,Vv.w) .w</pre>	<pre>void Q6_vgather_AQRMVw(HVX_Vector* A, HVX_VectorPred Qs, HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv)</pre>
<pre>vtmp.h=vgather (Rt,Mu,Vv.h) .h</pre>	<pre>void Q6_vgather_ARMVh(HVX_Vector* A, HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv)</pre>
<pre>vtmp.w=vgather (Rt,Mu,Vv.w) .w</pre>	<pre>void Q6_vgather_ARMVw(HVX_Vector* A, HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv)</pre>

Encoding

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	
ICLASS									NT		t5					Parse		u1														
0	0	1	0	1	1	1	1	0	0	0	t	t	t	t	t	P	P	u	-	-	0	0	0	-	-	-	v	v	v	v	v	vtmp.w=vgather(Rt,Mu,Vv.w).w
0	0	1	0	1	1	1	1	0	0	0	t	t	t	t	t	P	P	u	-	-	0	0	1	-	-	-	v	v	v	v	v	vtmp.h=vgather(Rt,Mu,Vv.h).h
ICLASS									NT		t5					Parse		u1						s2								
0	0	1	0	1	1	1	1	0	0	0	t	t	t	t	t	P	P	u	-	-	1	0	0	-	s	s	v	v	v	v	v	if (Qs4) vtmp.w=vgather(Rt,Mu,Vv.w).w
0	0	1	0	1	1	1	1	0	0	0	t	t	t	t	t	P	P	u	-	-	1	0	1	-	s	s	v	v	v	v	v	if (Qs4) vtmp.h=vgather(Rt,Mu,Vv.h).h

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s2	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v5	Field to encode register v

6.7 HVX/LOAD

The HVX/LOAD instruction subclass includes memory load instructions.

Load - aligned

Read a full vector register Vd from memory, using a vector-size-aligned address.

The operation has three ways to generate the memory pointer address:

- Rt with a constant 4-bit signed offset
- Rx with a signed post-increment
- Rx with a modifier register Mu post-increment

For the immediate forms, the value specifies the number of vectors worth of data. Mu contains the actual byte offset.

If the pointer presented to the instruction is not aligned, the instruction ignores the lower bits, yielding an aligned address.

If a scalar predicate register Pv evaluates true, load a full vector register Vs from memory, using a vector-size-aligned address. Otherwise, the operation becomes a NOP.

Syntax	Behavior
Vd=vmem(Rt)	Assembler mapped to: "Vd=vmem(Rt+#0)"
Vd=vmem(Rt):nt	Assembler mapped to: "Vd=vmem(Rt+#0):nt"
Vd=vmem(Rt+#s4)	EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1));
Vd=vmem(Rt+#s4):nt	EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1));
Vd=vmem(Rx++#s3)	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES;
Vd=vmem(Rx++#s3):nt	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES;
Vd=vmem(Rx++Mu)	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV;
Vd=vmem(Rx++Mu):nt	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV;
if ([!]Pv) Vd=vmem(Rt)	Assembler mapped to: "if ([!]Pv) Vd=vmem(Rt+#0)"
if ([!]Pv) Vd=vmem(Rt):nt	Assembler mapped to: "if ([!]Pv) Vd=vmem(Rt+#0):nt"

Syntax	Behavior
<code>if ([!]Pv) Vd=vmem(Rt+#s4)</code>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1)); } else { NOP; }</pre>
<code>if ([!]Pv) Vd=vmem(Rt+#s4):nt</code>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1)); } else { NOP; }</pre>
<code>if ([!]Pv) Vd=vmem(Rx++#s3)</code>	<pre>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<code>if ([!]Pv) Vd=vmem(Rx++#s3):nt</code>	<pre>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<code>if ([!]Pv) Vd=vmem(Rx++Mu)</code>	<pre>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV; } else { NOP; }</pre>
<code>if ([!]Pv) Vd=vmem(Rx++Mu):nt</code>	<pre>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV; } else { NOP; }</pre>

Class: COPROC_VMEM (slots 0,1)**Notes**

- This instruction can use any HVX resource.
- An optional nontemporal hint to the microarchitecture can be specified to indicate the data has no reuse.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS									NT	t5					Parse					d5												
0	0	1	0	1	0	0	0	0	0	0	t	t	t	t	t	P	P	i	0	0	i	i	i	0	0	0	d	d	d	d	d	Vd=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	0	1	0	t	t	t	t	t	P	P	i	0	0	i	i	i	0	0	0	d	d	d	d	d	Vd=vmem(Rt+#s4):nt
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	0	d	d	d	d	d	if (Pv) Vd=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	1	d	d	d	d	d	if (!Pv) Vd=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	0	d	d	d	d	d	if (Pv) Vd=vmem(Rt+#s4):nt
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	1	d	d	d	d	d	if (!Pv) Vd=vmem(Rt+#s4):nt
ICLASS									NT	x5					Parse					d5												
0	0	1	0	1	0	0	1	0	0	0	x	x	x	x	x	P	P	-	0	0	i	i	i	0	0	0	d	d	d	d	d	Vd=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	0	1	0	x	x	x	x	x	P	P	-	0	0	i	i	i	0	0	0	d	d	d	d	d	Vd=vmem(Rx++#s3):nt
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	0	d	d	d	d	d	if (Pv) Vd=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	1	d	d	d	d	d	if (!Pv) Vd=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	0	d	d	d	d	d	if (Pv) Vd=vmem(Rx++#s3):nt
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	1	d	d	d	d	d	if (!Pv) Vd=vmem(Rx++#s3):nt
ICLASS									NT	x5					Parse	u1						d5										
0	0	1	0	1	0	1	1	0	0	0	x	x	x	x	x	P	P	u	0	0	-	-	-	0	0	0	d	d	d	d	d	Vd=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	0	1	0	x	x	x	x	x	P	P	u	0	0	-	-	-	0	0	0	d	d	d	d	d	Vd=vmem(Rx++Mu):nt
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	0	d	d	d	d	d	if (Pv) Vd=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	1	d	d	d	d	d	if (!Pv) Vd=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	0	d	d	d	d	d	if (Pv) Vd=vmem(Rx++Mu):nt
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	1	d	d	d	d	d	if (!Pv) Vd=vmem(Rx++Mu):nt

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Load - immediate use

Read a full vector register Vd (and/or temporary vector register) from memory, using a vector-size-aligned address.

The operation has three ways to generate the memory pointer address:

- Rt with a constant 4-bit signed offset
- Rx with a signed post-increment
- Rx with a modifier register Mu post-increment

For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset.

If the pointer presented to the instruction is not aligned, the instruction ignores the lower bits, yielding an aligned address. The value is used immediately in the packet as a source operand of any instruction.

Vd.cur writes the load value to a vector register in addition to consuming it within the packet.

Vd.tmp does not write the incoming data to the vector register file. The data is only used as a source in the current packet, and then immediately discarded. This form does not consume any vector resources, allowing it to be placed in parallel with some instructions that a normal align load cannot.

If a scalar predicate register Pv evaluates true, load a full vector register Vs from memory, using a vector-size-aligned address. Otherwise, the operation becomes a NOP.

Syntax	Behavior
Vd.cur=vmem(Rt+#s4)	EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1));
Vd.cur=vmem(Rt+#s4):nt	EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1));
Vd.cur=vmem(Rx++#s3)	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES;
Vd.cur=vmem(Rx++#s3):nt	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES;
Vd.cur=vmem(Rx++Mu)	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV;
Vd.cur=vmem(Rx++Mu):nt	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV;
if ([!]Pv) Vd.cur=vmem(Rt)	Assembler mapped to: "if ([!]Pv) Vd.cur=vmem(Rt+#0)"
if ([!]Pv) Vd.cur=vmem(Rt):nt	Assembler mapped to: "if ([!]Pv) Vd.cur=vmem(Rt+#0):nt"

Syntax	Behavior
<code>if ([!]Pv) Vd.cur=vmem(Rt+#s4)</code>	<code>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1)); } else { NOP; }</code>
<code>if ([!]Pv) Vd.cur=vmem(Rt+#s4) :nt</code>	<code>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1)); } else { NOP; }</code>
<code>if ([!]Pv) Vd.cur=vmem(Rx++#s3)</code>	<code>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES; } else { NOP; }</code>
<code>if ([!]Pv) Vd.cur=vmem(Rx++#s3) :nt</code>	<code>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES; } else { NOP; }</code>
<code>if ([!]Pv) Vd.cur=vmem(Rx++Mu)</code>	<code>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV; } else { NOP; }</code>
<code>if ([!]Pv) Vd.cur=vmem(Rx++Mu) :nt</code>	<code>if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV; } else { NOP; }</code>

Class: COPROC_VMEM (slots 0,1)**Notes**

- This instruction can use any HVX resource.
- An optional nontemporal hint to the microarchitecture can be specified to indicate the data has no reuse.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS									NT	t5					Parse					d5												
0	0	1	0	1	0	0	0	0	0	0	t	t	t	t	t	P	P	i	0	0	i	i	i	0	0	1	d	d	d	d	d	Vd.cur=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	0	1	0	t	t	t	t	t	P	P	i	0	0	i	i	i	0	0	1	d	d	d	d	d	Vd.cur=vmem(Rt+#s4):nt
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	0	0	d	d	d	d	d	if (Pv) Vd.cur=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	0	1	d	d	d	d	d	if (!Pv) Vd.cur=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	0	0	d	d	d	d	d	if (Pv) Vd.cur=vmem(Rt+#s4):nt
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	0	1	d	d	d	d	d	if (!Pv) Vd.cur=vmem(Rt+#s4):nt
ICLASS									NT	x5					Parse					d5												
0	0	1	0	1	0	0	1	0	0	0	x	x	x	x	x	P	P	-	0	0	i	i	i	0	0	1	d	d	d	d	d	Vd.cur=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	0	1	0	x	x	x	x	x	P	P	-	0	0	i	i	i	0	0	1	d	d	d	d	d	Vd.cur=vmem(Rx++#s3):nt
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	0	0	d	d	d	d	d	if (Pv) Vd.cur=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	0	1	d	d	d	d	d	if (!Pv) Vd.cur=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	0	0	d	d	d	d	d	if (Pv) Vd.cur=vmem(Rx++#s3):nt
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	0	1	d	d	d	d	d	if (!Pv) Vd.cur=vmem(Rx++#s3):nt
ICLASS									NT	x5					Parse					u1	d5											
0	0	1	0	1	0	1	1	0	0	0	x	x	x	x	x	P	P	u	0	0	-	-	-	0	0	1	d	d	d	d	d	Vd.cur=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	0	1	0	x	x	x	x	x	P	P	u	0	0	-	-	-	0	0	1	d	d	d	d	d	Vd.cur=vmem(Rx++Mu):nt
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	0	0	d	d	d	d	d	if (Pv) Vd.cur=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	0	1	d	d	d	d	d	if (!Pv) Vd.cur=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	0	0	d	d	d	d	d	if (Pv) Vd.cur=vmem(Rx++Mu):nt
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	0	1	d	d	d	d	d	if (!Pv) Vd.cur=vmem(Rx++Mu):nt

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Load - temporary immediate use

Read a full vector register Vd (and/or temporary vector register) from memory, using a vector-size-aligned address.

The operation has three ways to generate the memory pointer address:

- Rt with a constant 4-bit signed offset
- Rx with a signed post-increment
- Rx with a modifier register Mu post-increment

For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset.

If the pointer presented to the instruction is not aligned, the instruction ignores the lower bits, yielding an aligned address. The value is used immediately in the packet as a source operand of any instruction.

Vd.tmp does not write the incoming data to the vector register file. The data is only used as a source in the current packet, and then immediately discarded. This form does not consume any vector resources, allowing it to be placed in parallel with some instructions that a normal align load cannot.

If a scalar predicate register Pv evaluates true, load a full vector register Vs from memory, using a vector-size-aligned address. Otherwise, the operation becomes a NOP.

Syntax	Behavior
Vd.tmp=vmem(Rt+#s4)	EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1));
Vd.tmp=vmem(Rt+#s4):nt	EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1));
Vd.tmp=vmem(Rx++#s3)	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES;
Vd.tmp=vmem(Rx++#s3):nt	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+#s*VBYTES;
Vd.tmp=vmem(Rx++Mu)	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV;
Vd.tmp=vmem(Rx++Mu):nt	EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); Rx=Rx+MuV;
if ([!]Pv) Vd.tmp=vmem(Rt)	Assembler mapped to: "if ([!]Pv) Vd.tmp=vmem(Rt+#0)"
if ([!]Pv) Vd.tmp=vmem(Rt):nt	Assembler mapped to: "if ([!]Pv) Vd.tmp=vmem(Rt+#0):nt"

Syntax	Behavior
<code>if ([!]Pv) Vd.tmp=vmem(Rt+#s4)</code>	<pre> if ([!]Pv[0]) { EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1)); } else { NOP; } </pre>
<code>if ([!]Pv) Vd.tmp=vmem(Rt+#s4) :nt</code>	<pre> if ([!]Pv[0]) { EA=Rt+#s*VBYTES; Vd = *(EA&~(ALIGNMENT-1)); ; } else { NOP; } </pre>
<code>if ([!]Pv) Vd.tmp=vmem(Rx++#s3)</code>	<pre> if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); ; Rx=Rx+#s*VBYTES; } else { NOP; } </pre>
<code>if ([!]Pv) Vd.tmp=vmem(Rx++#s3) :nt</code>	<pre> if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); ; Rx=Rx+#s*VBYTES; } else { NOP; } </pre>
<code>if ([!]Pv) Vd.tmp=vmem(Rx++Mu)</code>	<pre> if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); ; Rx=Rx+MuV; } else { NOP; } </pre>
<code>if ([!]Pv) Vd.tmp=vmem(Rx++Mu) :nt</code>	<pre> if ([!]Pv[0]) { EA=Rx; Vd = *(EA&~(ALIGNMENT-1)); ; Rx=Rx+MuV; } else { NOP; } </pre>

Class: COPROC_VMEM (slots 0,1)**Notes**

- This instruction can use any HVX resource.
- An optional nontemporal hint to the microarchitecture can be specified to indicate the data has no reuse.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS										NT	t5					Parse					d5											
0	0	1	0	1	0	0	0	0	0	0	t	t	t	t	t	P	P	i	0	0	i	i	i	0	1	0	d	d	d	d	d	Vd.tmp=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	0	1	0	t	t	t	t	t	P	P	i	0	0	i	i	i	0	1	0	d	d	d	d	d	Vd.tmp=vmem(Rt+#s4):nt
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	1	0	d	d	d	d	d	if (Pv) Vd.tmp=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	1	1	d	d	d	d	d	if (!Pv) Vd.tmp=vmem(Rt+#s4)
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	1	0	d	d	d	d	d	if (Pv) Vd.tmp=vmem(Rt+#s4):nt
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	1	1	1	d	d	d	d	d	if (!Pv) Vd.tmp=vmem(Rt+#s4):nt
ICLASS										NT	x5					Parse					d5											
0	0	1	0	1	0	0	1	0	0	0	x	x	x	x	x	P	P	-	0	0	i	i	i	0	1	0	d	d	d	d	d	Vd.tmp=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	0	1	0	x	x	x	x	x	P	P	-	0	0	i	i	i	0	1	0	d	d	d	d	d	Vd.tmp=vmem(Rx++#s3):nt
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	1	0	d	d	d	d	d	if (Pv) Vd.tmp=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	1	1	d	d	d	d	d	if (!Pv) Vd.tmp=vmem(Rx++#s3)
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	1	0	d	d	d	d	d	if (Pv) Vd.tmp=vmem(Rx++#s3):nt
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	1	1	1	d	d	d	d	d	if (!Pv) Vd.tmp=vmem(Rx++#s3):nt
ICLASS										NT	x5					Parse					u1	d5										
0	0	1	0	1	0	1	1	0	0	0	x	x	x	x	x	P	P	u	0	0	-	-	-	0	1	0	d	d	d	d	d	Vd.tmp=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	0	1	0	x	x	x	x	x	P	P	u	0	0	-	-	-	0	1	0	d	d	d	d	d	Vd.tmp=vmem(Rx++Mu):nt
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	1	0	d	d	d	d	d	if (Pv) Vd.tmp=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	1	1	d	d	d	d	d	if (!Pv) Vd.tmp=vmem(Rx++Mu)
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	1	0	d	d	d	d	d	if (Pv) Vd.tmp=vmem(Rx++Mu):nt
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	1	1	1	d	d	d	d	d	if (!Pv) Vd.tmp=vmem(Rx++Mu):nt

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Load - unaligned

Read a full vector register Vd from memory, using an arbitrary byte-aligned address.

The operation has three ways to generate the memory pointer address:

- Rt with a constant 4-bit signed offset
- Rx with a 3-bit signed post-increment
- Rx with a modifier register Mu post-increment

For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset. Unaligned memory operations require two accesses to the memory system, and thus incur increased power and bandwidth over aligned accesses. However, they require fewer instructions.

It is more efficient to use aligned memory operations when possible, and sometimes multiple aligned memory accesses and the valign operation, to synthesize a nonaligned access.

This instruction uses both slot 0 and slot 1, allowing at most 3 instructions to execute in a packet with vmemu in it.

Syntax	Behavior
Vd=vmemu (Rt)	Assembler mapped to: "Vd=vmemu (Rt+#0) "
Vd=vmemu (Rt+#s4)	EA=Rt+#s*VBYTES; Vd = *EA;
Vd=vmemu (Rx++#s3)	EA=Rx; Vd = *EA; Rx=Rx+#s*VBYTES;
Vd=vmemu (Rx++Mu)	EA=Rx; Vd = *EA; Rx=Rx+MuV;

Class: COPROC_VMEM (slots 0)

Notes

- This instruction uses the HVX permute resource.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS									NT	t5					Parse					d5												
0	0	1	0	1	0	0	0	0	0	0	t	t	t	t	t	P	P	i	0	0	i	i	i	1	1	1	d	d	d	d	d	Vd=vmemu(Rt+#s4)
ICLASS									NT	x5					Parse					d5												
0	0	1	0	1	0	0	1	0	0	0	x	x	x	x	x	P	P	-	0	0	i	i	i	1	1	1	d	d	d	d	d	Vd=vmemu(Rx++#s3)
ICLASS									NT	x5					Parse	u1	d5															
0	0	1	0	1	0	1	1	0	0	0	x	x	x	x	x	P	P	u	0	0	-	-	-	1	1	1	d	d	d	d	d	Vd=vmemu(Rx++Mu)

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u1	Field to encode register u
x5	Field to encode register x

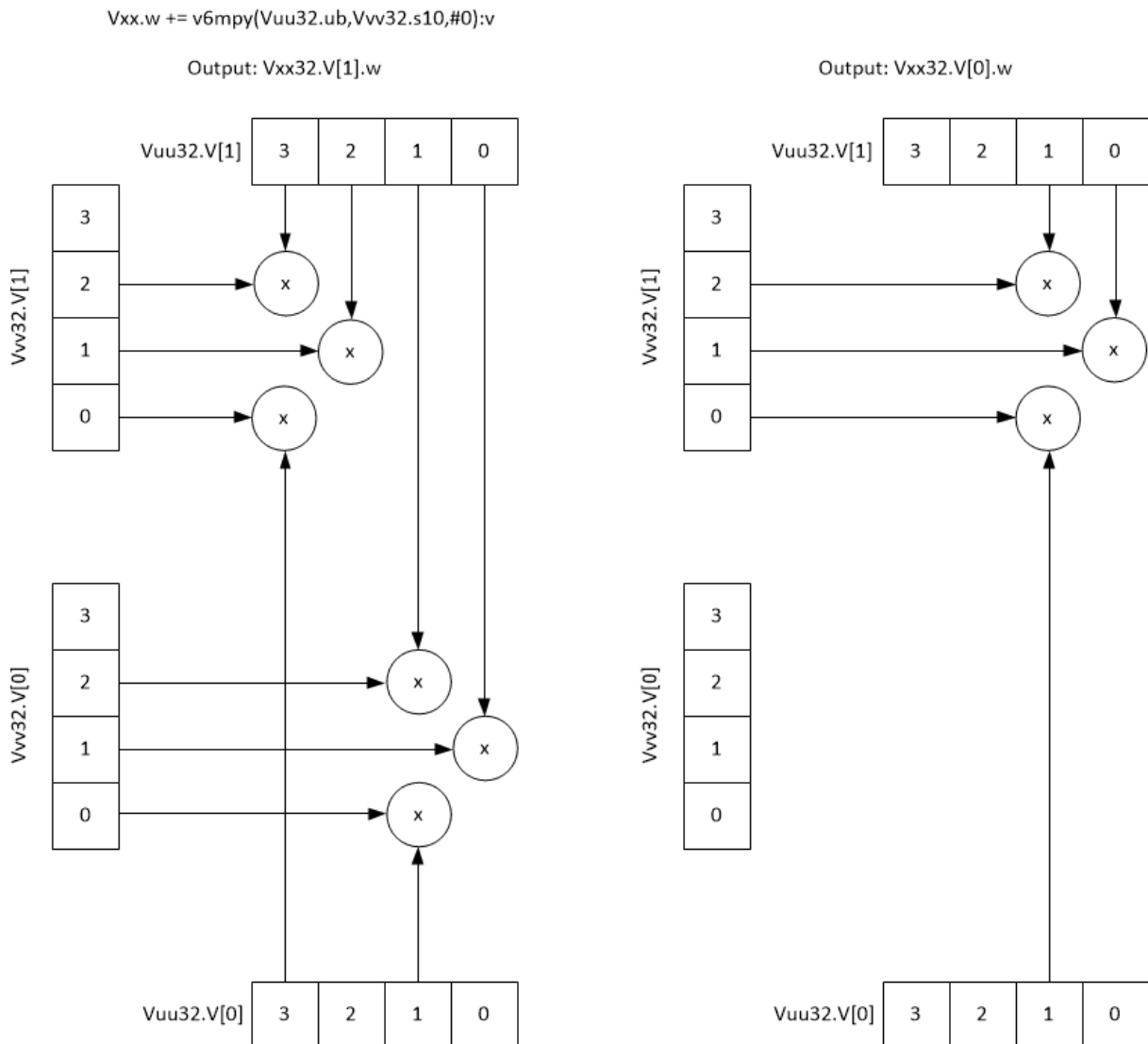
6.8 HVX/MPY-DOUBLE-RESOURCE

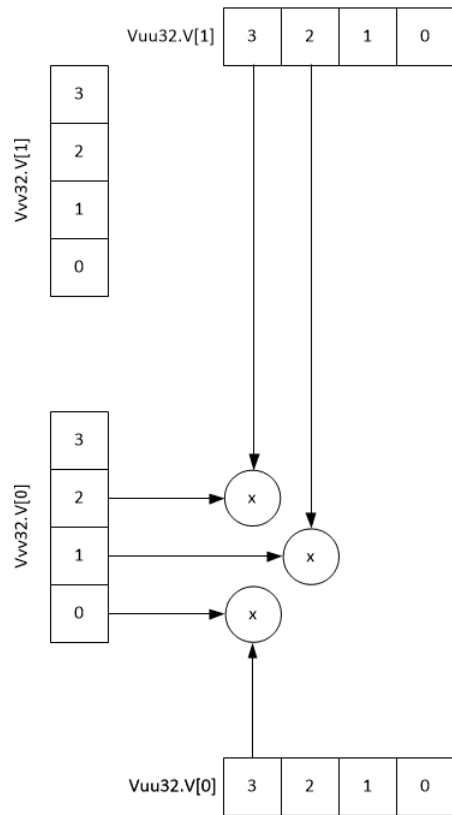
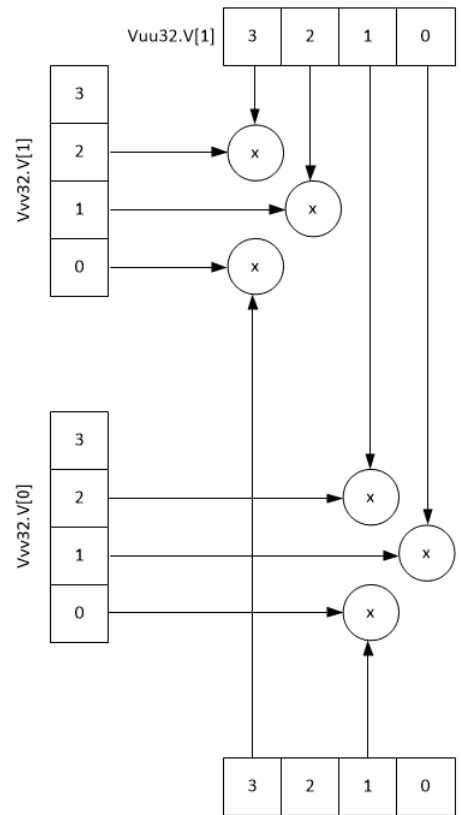
The HVX/MPY-DOUBLE-RESOURCE instruction subclass includes memory load instructions.

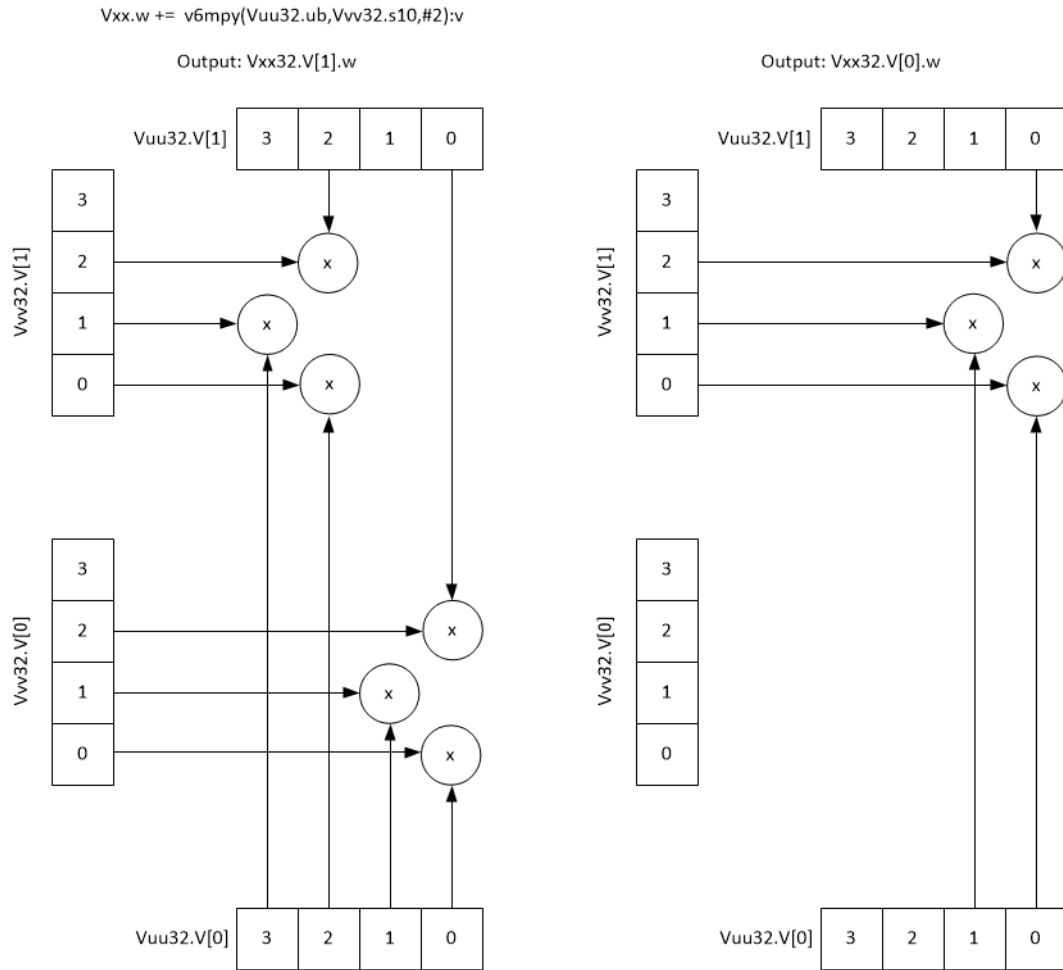
3x3 multiply for 2x2 tile

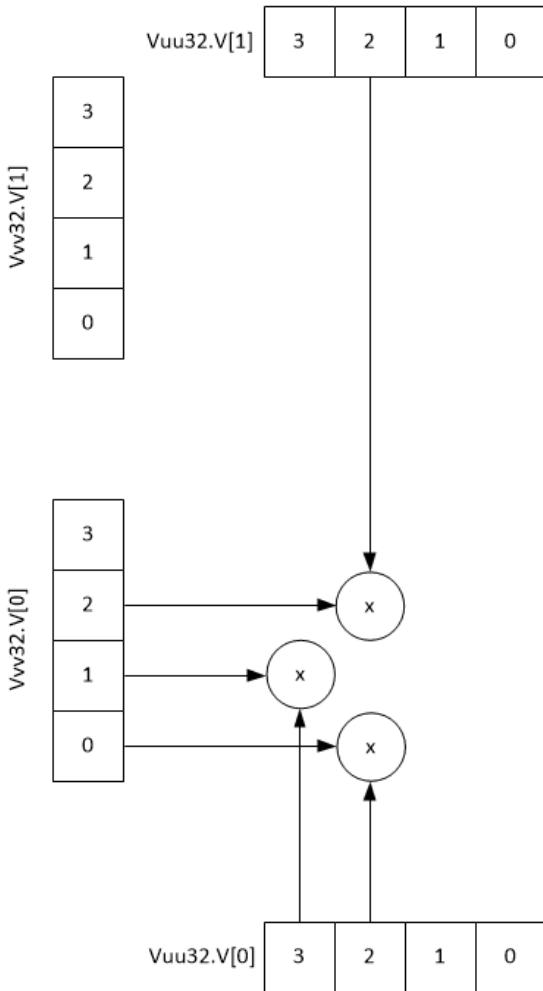
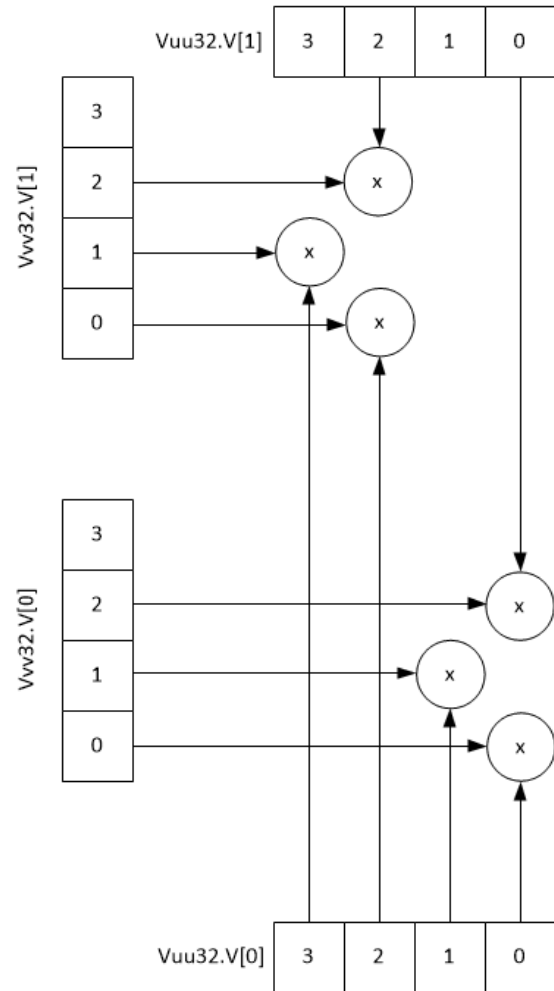
Multiply optimized for 3x3 filtering for a 2x2 tile format of two horizontal by two vertical bytes with three 10-bit coefficients. Byte 4 of the inlane word in the coefficient vector specifies the upper two bits for each coefficient.

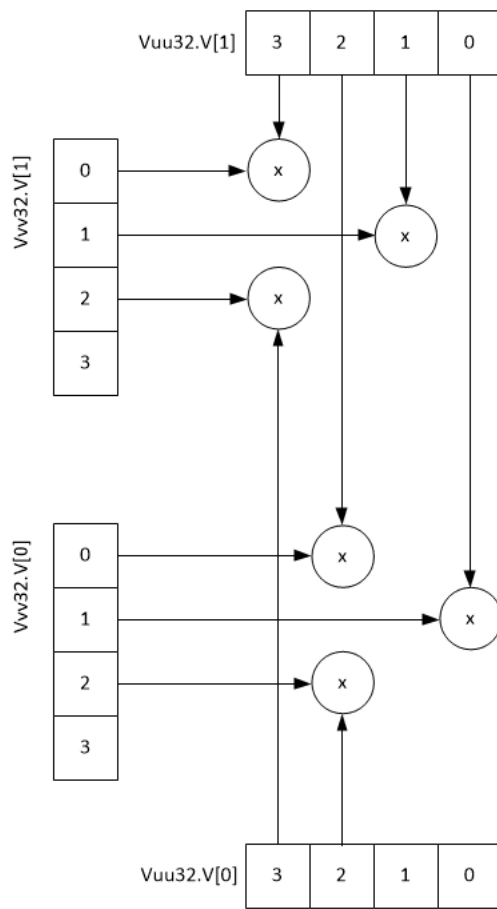
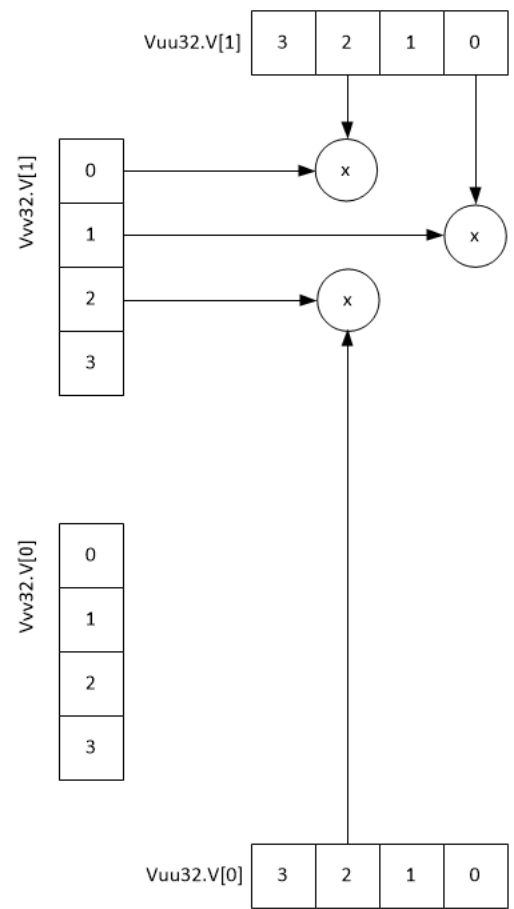
Accumulation is not shown to simplify the diagrams, but all multiplies are assumed to reduce and accumulate with the corresponding output.



$$V_{xx}.w += v6mpy(V_{uu}32.ub, V_{vv}32.s10, \#1); v$$
Output: $V_{xx}32.V[1].w$ Output: $V_{xx}32.V[0].w$ 

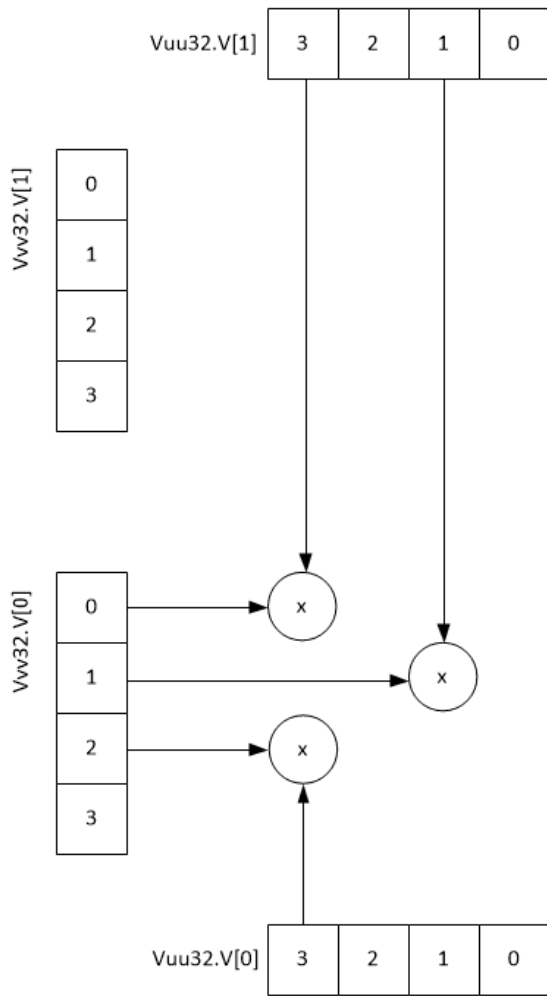


$$Vxx.w += v6mpy(Vuu32.ub, Vvv32.s10, \#3):v$$
Output: $Vxx32.V[1].w$ Output: $Vxx32.V[0].w$ 

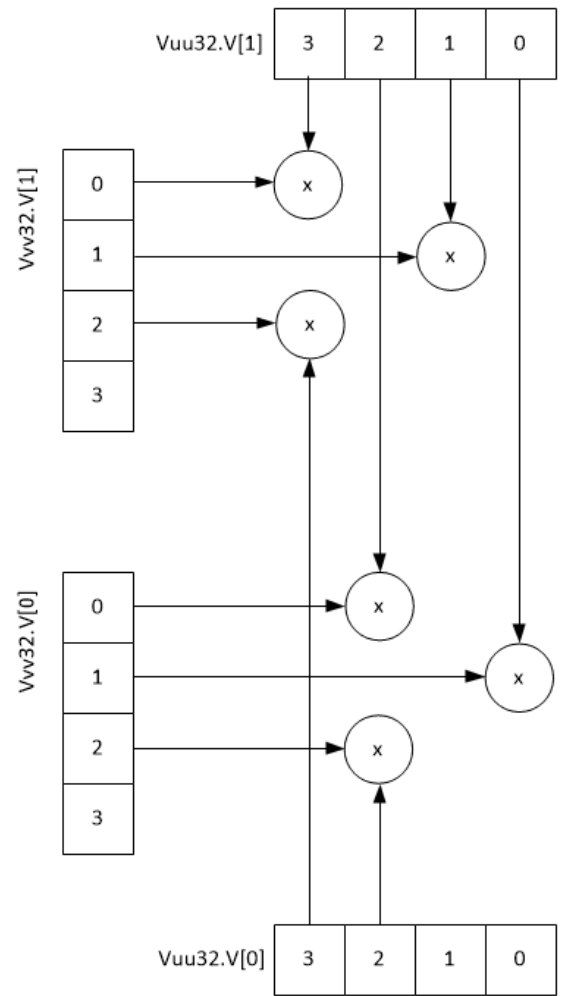
$V_{xx}.w += v6mpy(V_{uu}32.ub, V_{vv}32.s10, \#0):h$
Output: $V_{xx}32.V[1].w$ Output: $V_{xx}32.V[0].w$ 

$V_{xx.w} += v6mpy(V_{uu32.ub}, V_{vv32.s10}, \#1):h$

Output: $V_{xx32.V}[1].w$

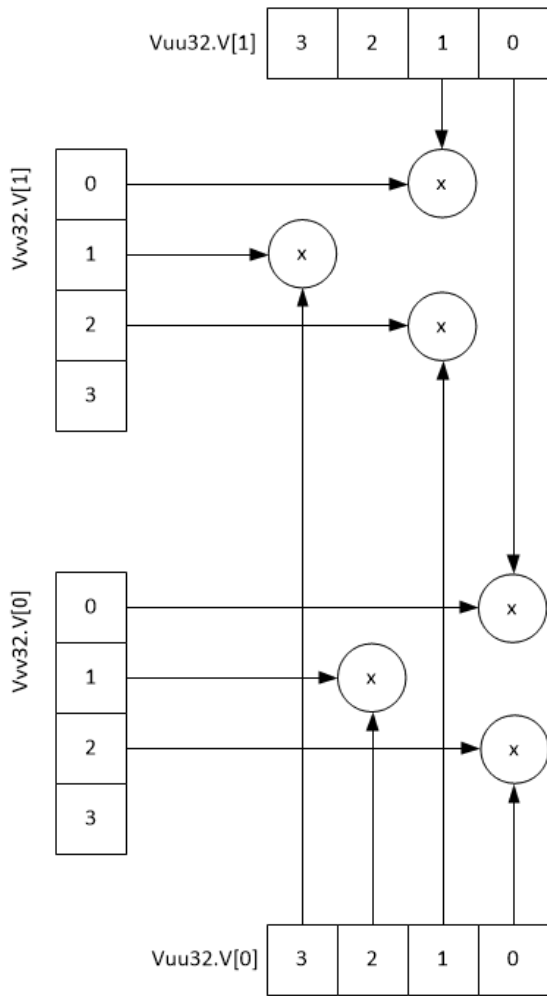


Output: $V_{xx32.V}[0].w$

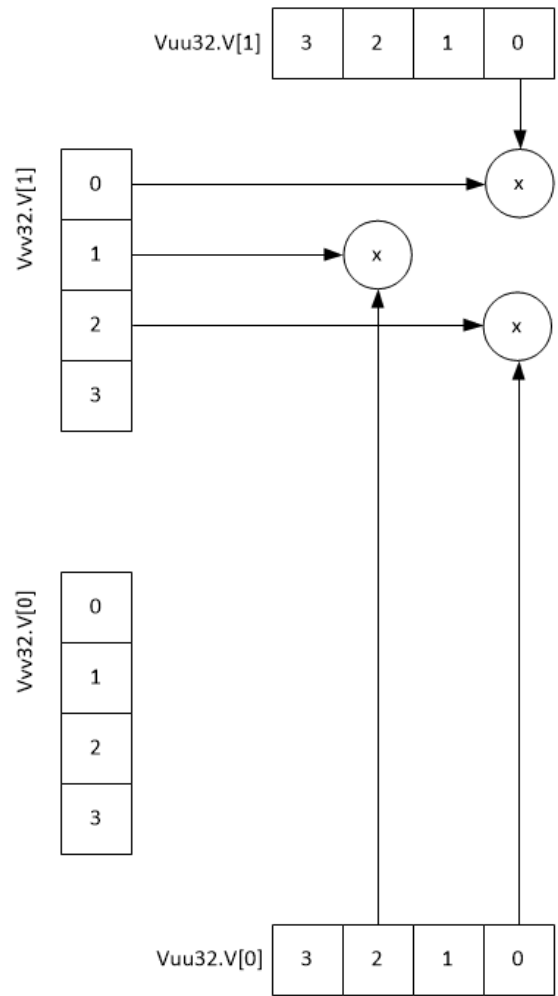


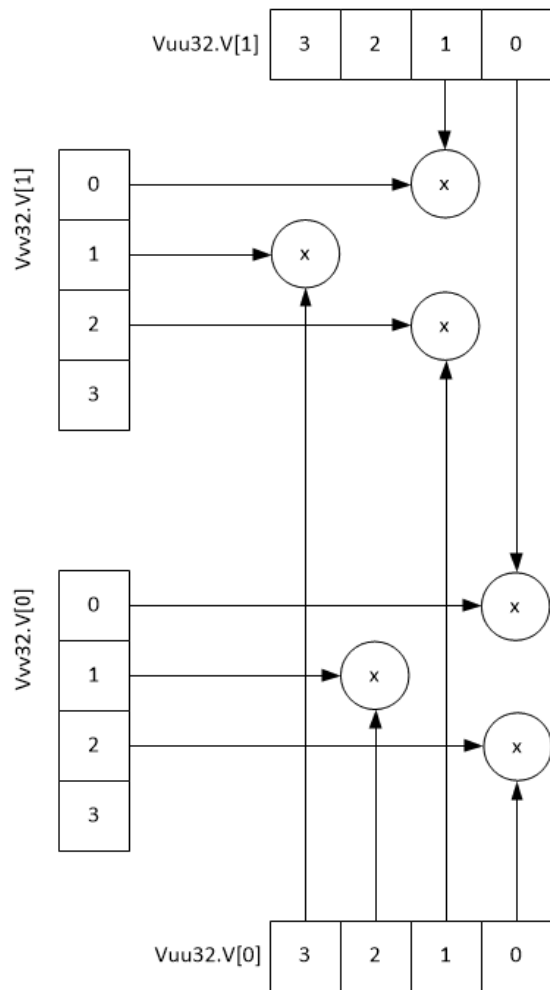
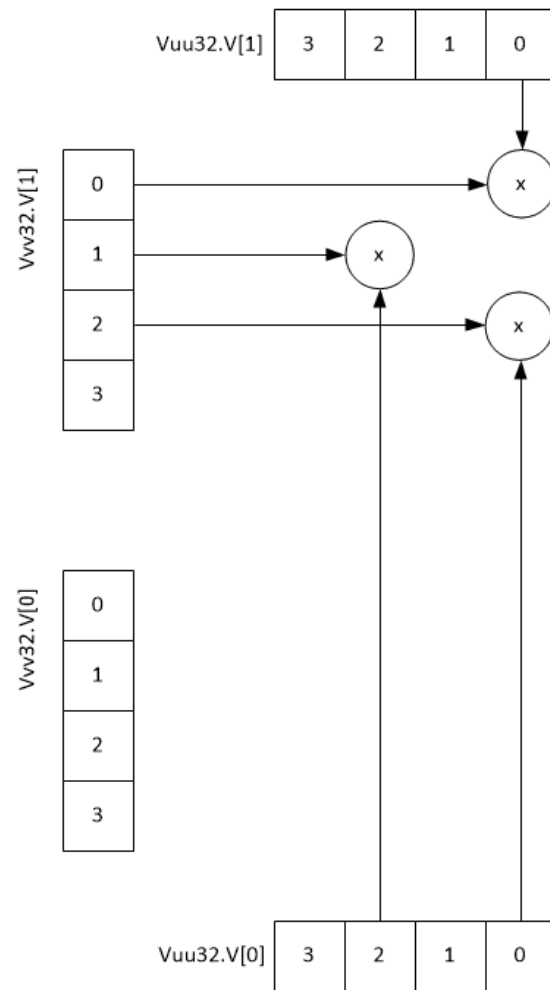
Vxx.w += v6mpy(Vuu32.ub,Vvv32.s10,#2):h

Output: Vxx32.V[1].w



Output: Vxx32.V[0].w



$$V_{xx}.w += v6mpy(V_{uu}32.ub, V_{vv}32.s10, \#2):h$$
Output: $V_{xx}32.V[1].w$ Output: $V_{xx}32.V[0].w$ **Class: COPROC_VX (slots 2,3)****Notes**

- This instruction uses both HVX multiply resources.
- The accumulator (V_{xx}) source of this instruction must be generate in the previous packet to avoid a stall. The accumulator cannot come from a `.tmp` operation.

Syntax

```
Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):h
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    c00=(((Vvv.v[0].uw[i].ub[3] >> (2 * 0)) &
3) << 8) | Vvv.v[0].uw[i].ub[0] << 6) >> 6;
    c01=(((Vvv.v[0].uw[i].ub[3] >> (2 * 1)) &
3) << 8) | Vvv.v[0].uw[i].ub[1] << 6) >> 6;
    c02=(((Vvv.v[0].uw[i].ub[3] >> (2 * 2)) &
3) << 8) | Vvv.v[0].uw[i].ub[2] << 6) >> 6;
    c10=(((Vvv.v[1].uw[i].ub[3] >> (2 * 0)) &
3) << 8) | Vvv.v[1].uw[i].ub[0] << 6) >> 6;
    c11=(((Vvv.v[1].uw[i].ub[3] >> (2 * 1)) &
3) << 8) | Vvv.v[1].uw[i].ub[1] << 6) >> 6;
    c12=(((Vvv.v[1].uw[i].ub[3] >> (2 * 2)) &
3) << 8) | Vvv.v[1].uw[i].ub[2] << 6) >> 6;
    if (#u == 0) {
        Vdd.v[1].w[i] = (Vuu.v[1].uw[i].ub[3] *
c10);
        Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] *
c11);
        Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c12);
        Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c00);
        Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] *
c01);
        Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[2] *
c02);
        Vdd.v[0].w[i] = (Vuu.v[1].uw[i].ub[2] *
c10);
        Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c11);
        Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c12);
    } else if (#u == 1) {
        Vdd.v[1].w[i] = (Vuu.v[1].uw[i].ub[3] *
c00);
        Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] *
c01);
        Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c02);
        Vdd.v[0].w[i] = (Vuu.v[1].uw[i].ub[3] *
c10);
        Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] *
c11);
        Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] *
c12);
        Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] *
c00);
        Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c01);
        Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c02);
    } else if (#u == 2) {
        Vdd.v[1].w[i] = (Vuu.v[1].uw[i].ub[1] *
c10);
        Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
        Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c12);
        Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] *
c00);
        Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[2] *
c01);
    }
}
```

Syntax

```
Vdd.w=v6mpy(Vuu.ub, Vvv.b, #u2) :h
```

Behavior

```
Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[0] * c02);
Vdd.v[0].w[i] = (Vuu.v[1].uw[i].ub[0] *
c10);
Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c11);
Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c12);
} else if (#u == 3) {
Vdd.v[1].w[i] = (Vuu.v[1].uw[i].ub[1] *
c00);
Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c01);
Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c02);
Vdd.v[0].w[i] = (Vuu.v[1].uw[i].ub[1] *
c10);
Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c12);
Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c00);
Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c01);
Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c02);
}
}
```

```
Vdd.w=v6mpy(Vuu.ub, Vvv.b, #u2) :v
```

```
for (i = 0; i < VELEM(32); i++) {
c00=((((Vvv.v[0].uw[i].ub[3] >> (2 * 0)) &
3) << 8) | Vvv.v[0].uw[i].ub[0] << 6) >> 6;
c01=((((Vvv.v[0].uw[i].ub[3] >> (2 * 1)) &
3) << 8) | Vvv.v[0].uw[i].ub[1] << 6) >> 6;
c02=((((Vvv.v[0].uw[i].ub[3] >> (2 * 2)) &
3) << 8) | Vvv.v[0].uw[i].ub[2] << 6) >> 6;
c10=((((Vvv.v[1].uw[i].ub[3] >> (2 * 0)) &
3) << 8) | Vvv.v[1].uw[i].ub[0] << 6) >> 6;
c11=((((Vvv.v[1].uw[i].ub[3] >> (2 * 1)) &
3) << 8) | Vvv.v[1].uw[i].ub[1] << 6) >> 6;
c12=((((Vvv.v[1].uw[i].ub[3] >> (2 * 2)) &
3) << 8) | Vvv.v[1].uw[i].ub[2] << 6) >> 6;
if (#u == 0) {
Vdd.v[1].w[i] = (Vuu.v[0].uw[i].ub[3] *
c10);
Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c11);
Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[3] *
c12);
Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c00);
Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] *
c01);
Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] *
c02);
Vdd.v[0].w[i] = (Vuu.v[0].uw[i].ub[1] *
c10);
Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c11);
Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] *
c12);
```


Syntax

```
Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):v
```

Behavior

```

} else if (#u == 1) {
    Vdd.v[1].w[i] = (Vuu.v[0].uw[i].ub[3] *
c00);
    Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c01);
    Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[3] *
c02);
    Vdd.v[0].w[i] = (Vuu.v[0].uw[i].ub[3] *
c10);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] *
c11);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[3] *
c12);
    Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c00);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c01);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] *
c02);
} else if (#u == 2) {
    Vdd.v[1].w[i] = (Vuu.v[0].uw[i].ub[2] *
c10);
    Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
    Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c12);
    Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[0] *
c00);
    Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c01);
    Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] *
c02);
    Vdd.v[0].w[i] = (Vuu.v[0].uw[i].ub[0] *
c10);
    Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c11);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c12);
} else if (#u == 3) {
    Vdd.v[1].w[i] = (Vuu.v[0].uw[i].ub[2] *
c00);
    Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c01);
    Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c02);
    Vdd.v[0].w[i] = (Vuu.v[0].uw[i].ub[2] *
c10);
    Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] *
c12);
    Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c00);
    Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c01);
    Vdd.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c02);
}
}

```

```
Vdd.w=v6mpy(Vuu.ub,Vvv.b10,#u2)
:h
```

Assembler mapped to:

```
"Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):h"
```

Syntax	Behavior
<pre>Vdd.w=v6mpy(Vuu.ub,Vvv.b10,#u2) :v</pre>	<pre>Assembler mapped to: "Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):v"</pre>
<pre>Vxx.w+=v6mpy(Vuu.ub,Vvv.b,#u2) :h</pre>	<pre>for (i = 0; i < VELEM(32); i++) { c00=((((Vvv.v[0].uw[i].ub[3] >> (2 * 0)) & 3) << 8) Vvv.v[0].uw[i].ub[0] << 6) >> 6; c01=((((Vvv.v[0].uw[i].ub[3] >> (2 * 1)) & 3) << 8) Vvv.v[0].uw[i].ub[1] << 6) >> 6; c02=((((Vvv.v[0].uw[i].ub[3] >> (2 * 2)) & 3) << 8) Vvv.v[0].uw[i].ub[2] << 6) >> 6; c10=((((Vvv.v[1].uw[i].ub[3] >> (2 * 0)) & 3) << 8) Vvv.v[1].uw[i].ub[0] << 6) >> 6; c11=((((Vvv.v[1].uw[i].ub[3] >> (2 * 1)) & 3) << 8) Vvv.v[1].uw[i].ub[1] << 6) >> 6; c12=((((Vvv.v[1].uw[i].ub[3] >> (2 * 2)) & 3) << 8) Vvv.v[1].uw[i].ub[2] << 6) >> 6; if (#u == 0) { Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[3] * c10); Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] * c11); Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] * c12); Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] * c00); Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] * c01); Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[2] * c02); Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] * c10); Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] * c11); Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] * c12); } else if (#u == 1) { Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[3] * c00); Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] * c01); Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] * c02); Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[3] * c10); Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] * c11); Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] * c12); Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] * c00); Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] * c01); Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] * c02); } else if (#u == 2) { Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] * c10); Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] * c11); Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] * c12); Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] * c00);</pre>

Syntax

```
Vxx.w+=v6mpy (Vuu.ub, Vvv.b, #u2) :
h
```

Behavior

```
Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[2] *
c01);
Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[0] *
c02);
Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c10);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c11);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c12);
} else if (#u == 3) {
Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] *
c00);
Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c01);
Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c02);
Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] *
c10);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c12);
Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c00);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c01);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c02);
}
```

```
Vxx.w+=v6mpy (Vuu.ub, Vvv.b, #u2) :
v
```

```
for (i = 0; i < VELEM(32); i++) {
c00=(((Vvv.v[0].uw[i].ub[3] >> (2 * 0)) &
3) << 8) | Vvv.v[0].uw[i].ub[0] << 6) >> 6;
c01=(((Vvv.v[0].uw[i].ub[3] >> (2 * 1)) &
3) << 8) | Vvv.v[0].uw[i].ub[1] << 6) >> 6;
c02=(((Vvv.v[0].uw[i].ub[3] >> (2 * 2)) &
3) << 8) | Vvv.v[0].uw[i].ub[2] << 6) >> 6;
c10=(((Vvv.v[1].uw[i].ub[3] >> (2 * 0)) &
3) << 8) | Vvv.v[1].uw[i].ub[0] << 6) >> 6;
c11=(((Vvv.v[1].uw[i].ub[3] >> (2 * 1)) &
3) << 8) | Vvv.v[1].uw[i].ub[1] << 6) >> 6;
c12=(((Vvv.v[1].uw[i].ub[3] >> (2 * 2)) &
3) << 8) | Vvv.v[1].uw[i].ub[2] << 6) >> 6;
if (#u == 0) {
Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] * c10);
Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c11);
Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[3] *
c12);
Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c00);
Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] *
c01);
Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] * c02);
Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c10);
Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] * c11);
Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] *
c12);
}
```

Syntax

```
Vxx.w+=v6mpy (Vuu.ub,Vvv.b,#u2):
v
```

Behavior

```

} else if (#u == 1) {
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c00);
    Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c01);
    Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[3] *
c02);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] *
c10);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] *
c11);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[3] *
c12);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c00);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c01);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[1] *
c02);
} else if (#u == 2) {
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[2] *
c10);
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
    Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c12);
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[0] *
c00);
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[1] *
c01);
    Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[0] *
c02);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c10);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c11);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c12);
} else if (#u == 3) {
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[2] *
c00);
    Vxx.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] *
c01);
    Vxx.v[1].w[i] += (Vuu.v[1].uw[i].ub[2] *
c02);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] *
c10);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] *
c11);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[2] *
c12);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[0] *
c00);
    Vxx.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] *
c01);
    Vxx.v[0].w[i] += (Vuu.v[1].uw[i].ub[0] *
c02);
}
}

```

Intrinsics

Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):h	HVX_VectorPair Q6_Ww_v6mpy_WubWbI_h(HVX_VectorPair Vuu, HVX_VectorPair Vvv, Word32 Iu2)
Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):v	HVX_VectorPair Q6_Ww_v6mpy_WubWbI_v(HVX_VectorPair Vuu, HVX_VectorPair Vvv, Word32 Iu2)
Vxx.w+=v6mpy(Vuu.ub,Vvv.b,#u2):h	HVX_VectorPair Q6_Ww_v6mpyacc_WwWubWbI_h(HVX_VectorPair Vxx, HVX_VectorPair Vuu, HVX_VectorPair Vvv, Word32 Iu2)
Vxx.w+=v6mpy(Vuu.ub,Vvv.b,#u2):v	HVX_VectorPair Q6_Ww_v6mpyacc_WwWubWbI_v(HVX_VectorPair Vxx, HVX_VectorPair Vuu, HVX_VectorPair Vvv, Word32 Iu2)

Encoding

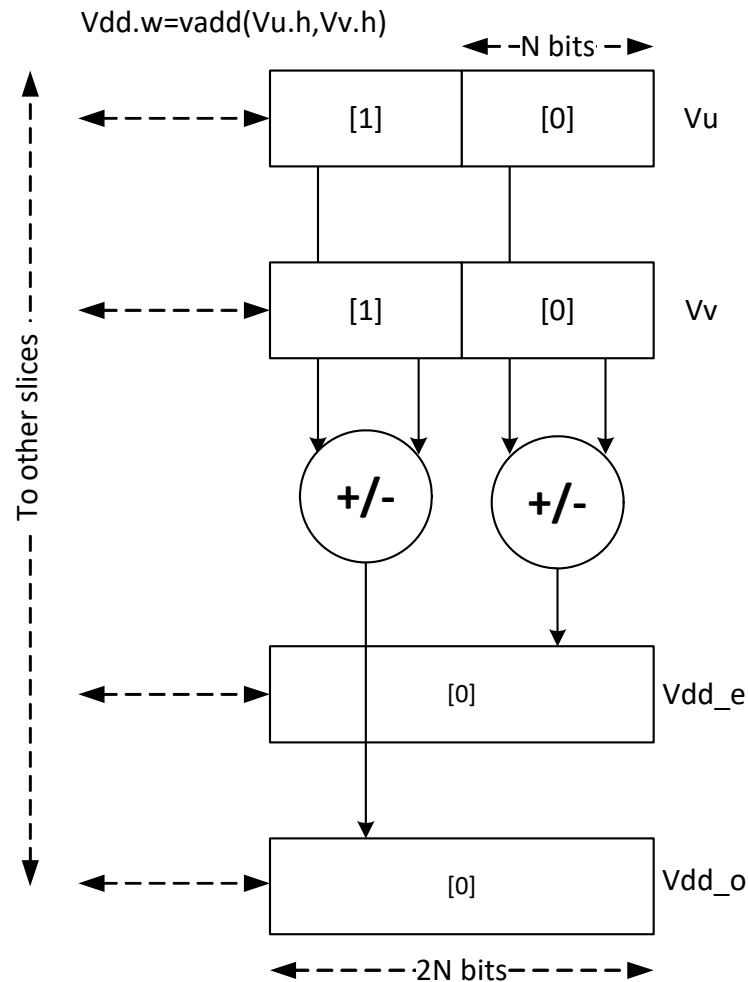
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																	Parse		u5					x5								
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	i	i	x	x	x	x	x	Vxx.w+=v6mpy(Vuu.ub,Vvv.b,#u2):v
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	i	i	x	x	x	x	x	Vxx.w+=v6mpy(Vuu.ub,Vvv.b,#u2):h
ICLASS																	Parse		u5					d5								
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	i	i	d	d	d	d	d	Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):v
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	i	i	d	d	d	d	d	Vdd.w=v6mpy(Vuu.ub,Vvv.b,#u2):h

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Arithmetic widening

Add or subtract the elements of vector registers V_u and V_v . The resulting elements are double the width of the input size to capture any data growth in the result. The result is placed in a double vector register.

Supports unsigned byte, and signed and unsigned halfword.



Syntax

$Vdd.h=vadd(Vu.ub,Vv.ub)$

$Vdd.h=vsub(Vu.ub,Vv.ub)$

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = Vu.uh[i].ub[0] +
    Vv.uh[i].ub[0];
    Vdd.v[1].h[i] = Vu.uh[i].ub[1] +
    Vv.uh[i].ub[1];
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = Vu.uh[i].ub[0] -
    Vv.uh[i].ub[0];
    Vdd.v[1].h[i] = Vu.uh[i].ub[1] -
    Vv.uh[i].ub[1];
}
```

Syntax	Behavior
<code>Vdd.w=vadd(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = Vu.w[i].h[0] + Vv.w[i].h[0]; Vdd.v[1].w[i] = Vu.w[i].h[1] + Vv.w[i].h[1]; }</pre>
<code>Vdd.w=vadd(Vu.uh,Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = Vu.uw[i].uh[0] + Vv.uw[i].uh[0]; Vdd.v[1].w[i] = Vu.uw[i].uh[1] + Vv.uw[i].uh[1]; }</pre>
<code>Vdd.w=vsub(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = Vu.w[i].h[0] - Vv.w[i].h[0]; Vdd.v[1].w[i] = Vu.w[i].h[1] - Vv.w[i].h[1]; }</pre>
<code>Vdd.w=vsub(Vu.uh,Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = Vu.uw[i].uh[0] - Vv.uw[i].uh[0]; Vdd.v[1].w[i] = Vu.uw[i].uh[1] - Vv.uw[i].uh[1]; }</pre>
<code>Vxx.h+=vadd(Vu.ub,Vv.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += Vu.h[i].ub[0] + Vv.h[i].ub[0]; Vxx.v[1].h[i] += Vu.h[i].ub[1] + Vv.h[i].ub[1]; }</pre>
<code>Vxx.w+=vadd(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += Vu.w[i].h[0] + Vv.w[i].h[0]; Vxx.v[1].w[i] += Vu.w[i].h[1] + Vv.w[i].h[1]; }</pre>
<code>Vxx.w+=vadd(Vu.uh,Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += Vu.w[i].uh[0] + Vv.w[i].uh[0]; Vxx.v[1].w[i] += Vu.w[i].uh[1] + Vv.w[i].uh[1]; }</pre>

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

Vdd.h=vadd(Vu.ub,Vv.ub)	HVX_VectorPair Q6_Wh_vadd_VubVub(HVX_Vector Vu, HVX_Vector Vv)
Vdd.h=vsub(Vu.ub,Vv.ub)	HVX_VectorPair Q6_Wh_vsub_VubVub(HVX_Vector Vu, HVX_Vector Vv)
Vdd.w=vadd(Vu.h,Vv.h)	HVX_VectorPair Q6_Ww_vadd_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vdd.w=vadd(Vu.uh,Vv.uh)	HVX_VectorPair Q6_Ww_vadd_VuhVuh(HVX_Vector Vu, HVX_Vector Vv)
Vdd.w=vsub(Vu.h,Vv.h)	HVX_VectorPair Q6_Ww_vsub_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vdd.w=vsub(Vu.uh,Vv.uh)	HVX_VectorPair Q6_Ww_vsub_VuhVuh(HVX_Vector Vu, HVX_Vector Vv)
Vxx.h+=vadd(Vu.ub,Vv.ub)	HVX_VectorPair Q6_Wh_vaddacc_WhVubVub(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)
Vxx.w+=vadd(Vu.h,Vv.h)	HVX_VectorPair Q6_Ww_vaddacc_WwVhVh(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)
Vxx.w+=vadd(Vu.uh,Vv.uh)	HVX_VectorPair Q6_Ww_vaddacc_WwVuhVuh(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)

Encoding

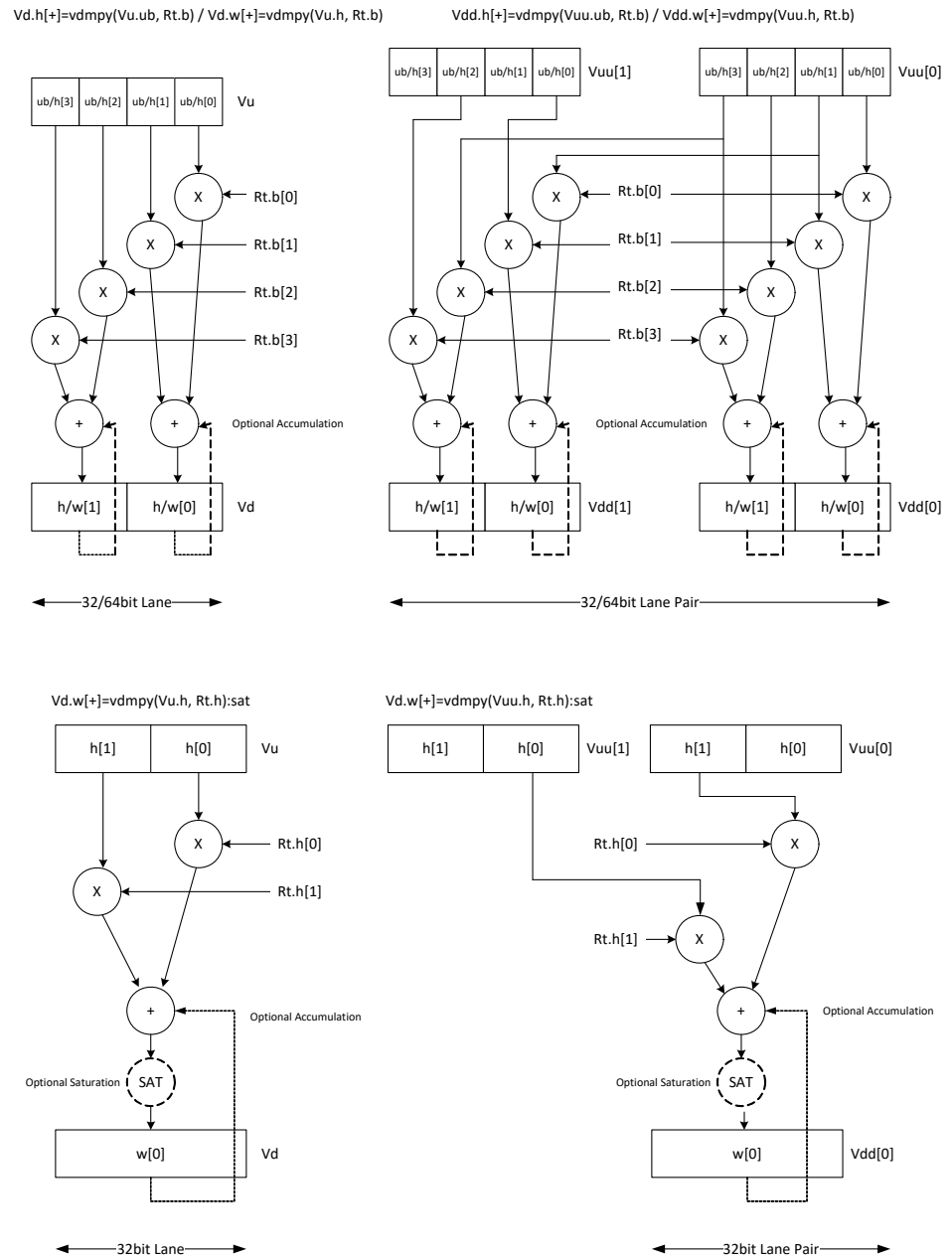
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	Vxx.w+=vadd(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	Vxx.w+=vadd(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vxx.h+=vadd(Vu.ub,Vv.ub)
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vdd.h=vadd(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd.w=vadd(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.w=vadd(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.h=vsub(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.w=vsub(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd.w=vsub(Vu.h,Vv.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

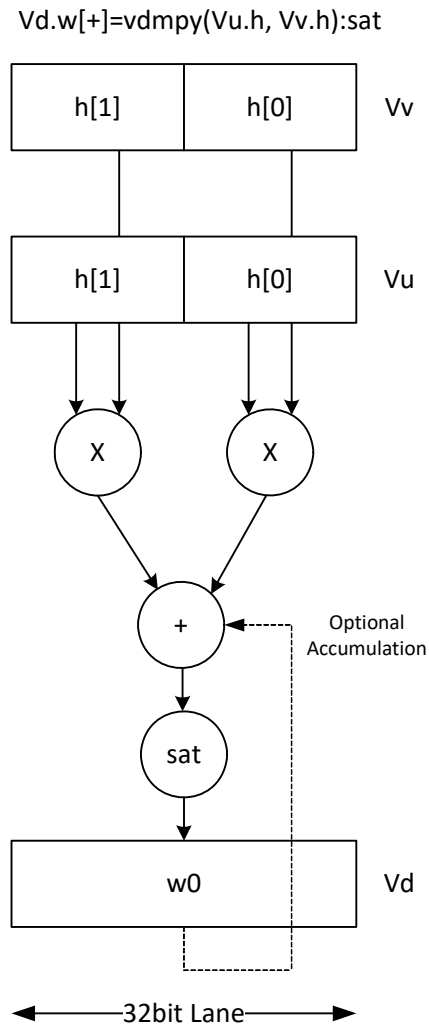
Multiply with 2-wide reduction

Multiply elements from Vu by the corresponding elements in the scalar register Rt. The products are added in pairs to yield a by-2 reduction. The products can be accumulated with Vx, with optional saturation after summation.

Supports multiplication of unsigned bytes by bytes, halfwords by signed bytes, and halfwords by halfwords. The double-vector version performs a sliding window 2-way reduction, where the odd register output contains the offset computation.



Multiply halfword elements from vector register Vu by the corresponding halfword elements in the vector register Vv. The products are added in pairs to make a 32-bit wide sum. The sum is optionally accumulated with the vector register destination Vx, and then saturated to 32 bits.

**Syntax**

```
Vd.w=vdmppy(Vu.h,Rt.h):sat
```

```
Vd.w=vdmppy(Vu.h,Rt.uh):sat
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    accum = (Vu.w[i].h[0] * Rt.h[0]);
    accum += (Vu.w[i].h[1] * Rt.h[1]);
    Vd.w[i] = sat_32(accum);
}
```

```
for (i = 0; i < VELEM(32); i++) {
    accum = (Vu.w[i].h[0] * Rt.uh[0]);
    accum += (Vu.w[i].h[1] * Rt.uh[1]);
    Vd.w[i] = sat_32(accum);
}
```

Syntax	Behavior
<code>Vd.w=vdmpy(Vu.h,Vv.h):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum = (Vu.w[i].h[0] * Vv.w[i].h[0]); accum += (Vu.w[i].h[1] * Vv.w[i].h[1]); Vd.w[i] = sat_32(accum) ; }</pre>
<code>Vd.w=vdmpy(Vuu.h,Rt.h):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum = (Vuu.v[0].w[i].h[1] * Rt.h[0]); accum += (Vuu.v[1].w[i].h[0] * Rt.h[1]); Vd.w[i] = sat_32(accum) ; }</pre>
<code>Vd.w=vdmpy(Vuu.h,Rt.uh,#1):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum = (Vuu.v[0].w[i].h[1] * Rt.uh[0]); accum += (Vuu.v[1].w[i].h[0] * Rt.uh[1]); Vd.w[i] = sat_32(accum) ; }</pre>
<code>Vdd.h=vdmpy(Vuu.ub,Rt.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].h[i] = (Vuu.v[0].uh[i].ub[0] * Rt.b[(2*i) % 4]); Vdd.v[0].h[i] += (Vuu.v[0].uh[i].ub[1] * Rt.b[(2*i+1)%4]); Vdd.v[1].h[i] = (Vuu.v[0].uh[i].ub[1] * Rt.b[(2*i) % 4]); Vdd.v[1].h[i] += (Vuu.v[1].uh[i].ub[0] * Rt.b[(2*i+1)%4]) ; }</pre>
<code>Vdd.w=vdmpy(Vuu.h,Rt.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vuu.v[0].w[i].h[0] * Rt.b[(2*i+0)%4]); Vdd.v[0].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+1)%4]); Vdd.v[1].w[i] = (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+0)%4]); Vdd.v[1].w[i] += (Vuu.v[1].w[i].h[0] * Rt.b[(2*i+1)%4]) ; }</pre>
<code>Vx.w+=vdmpy(Vu.h,Rt.h):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum = Vx.w[i]; accum += (Vu.w[i].h[0] * Rt.h[0]); accum += (Vu.w[i].h[1] * Rt.h[1]); Vx.w[i] = sat_32(accum) ; }</pre>
<code>Vx.w+=vdmpy(Vu.h,Rt.uh):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum=Vx.w[i]; accum += (Vu.w[i].h[0] * Rt.uh[0]); accum += (Vu.w[i].h[1] * Rt.uh[1]); Vx.w[i] = sat_32(accum) ; }</pre>
<code>Vx.w+=vdmpy(Vu.h,Vv.h):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum = (Vu.w[i].h[0] * Vv.w[i].h[0]); accum += (Vu.w[i].h[1] * Vv.w[i].h[1]); Vx.w[i] = sat_32(Vx.w[i]+accum) ; }</pre>

Syntax	Behavior
<code>Vx.w+=vdmpy(Vuu.h,Rt.h):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum = Vx.w[i]; accum += (Vuu.v[0].w[i].h[1] * Rt.h[0]); accum += (Vuu.v[1].w[i].h[0] * Rt.h[1]); Vx.w[i] = sat_32(accum); }</pre>
<code>Vx.w+=vdmpy(Vuu.h,Rt.uh,#1):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { accum=Vx.w[i]; accum += (Vuu.v[0].w[i].h[1] * Rt.uh[0]); accum += (Vuu.v[1].w[i].h[0] * Rt.uh[1]); Vx.w[i] = sat_32(accum); }</pre>
<code>Vxx.h+=vdmpy(Vuu.ub,Rt.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vuu.v[0].uh[i].ub[0] * Rt.b[(2*i) % 4]); Vxx.v[0].h[i] += (Vuu.v[0].uh[i].ub[1] * Rt.b[(2*i+1)%4]); Vxx.v[1].h[i] += (Vuu.v[0].uh[i].ub[1] * Rt.b[(2*i) % 4]); Vxx.v[1].h[i] += (Vuu.v[1].uh[i].ub[0] * Rt.b[(2*i+1)%4]); }</pre>
<code>Vxx.w+=vdmpy(Vuu.h,Rt.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += (Vuu.v[0].w[i].h[0] * Rt.b[(2*i+0)%4]); Vxx.v[0].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+1)%4]); Vxx.v[1].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+0)%4]); Vxx.v[1].w[i] += (Vuu.v[1].w[i].h[0] * Rt.b[(2*i+1)%4]); }</pre>

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

<code>Vd.w=vdmpy(Vu.h,Rt.h):sat</code>	HVX_Vector Q6_Vw_vdmpy_VhRh_sat (HVX_Vector Vu, Word32 Rt)
<code>Vd.w=vdmpy(Vu.h,Rt.uh):sat</code>	HVX_Vector Q6_Vw_vdmpy_VhRuh_sat (HVX_Vector Vu, Word32 Rt)
<code>Vd.w=vdmpy(Vu.h,Vv.h):sat</code>	HVX_Vector Q6_Vw_vdmpy_VhVh_sat (HVX_Vector Vu, HVX_Vector Vv)
<code>Vd.w=vdmpy(Vuu.h,Rt.h):sat</code>	HVX_VectorPair Q6_Vw_vdmpy_WhRh_sat (HVX_VectorPair Vuu, Word32 Rt)
<code>Vd.w=vdmpy(Vuu.h,Rt.uh,#1):sat</code>	HVX_VectorPair Q6_Vw_vdmpy_WhRuh_sat (HVX_VectorPair Vuu, Word32 Rt)
<code>Vdd.h=vdmpy(Vuu.ub,Rt.b)</code>	HVX_VectorPair Q6_Wh_vdmpy_WubRb (HVX_VectorPair Vuu, Word32 Rt)

Vdd.w=vdmpy(Vuu.h,Rt.b)	HVX_VectorPair Q6_Ww_vdmpy_WhRb (HVX_VectorPair Vuu, Word32 Rt)
Vx.w+=vdmpy(Vu.h,Rt.h):sat	HVX_Vector Q6_Vw_vdmpyacc_VwVhRh_sat (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
Vx.w+=vdmpy(Vu.h,Rt.uh):sat	HVX_Vector Q6_Vw_vdmpyacc_VwVhRuh_sat (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
Vx.w+=vdmpy(Vu.h,Vv.h):sat	HVX_Vector Q6_Vw_vdmpyacc_VwVhVh_sat (HVX_Vector Vx, HVX_Vector Vu, HVX_Vector Vv)
Vx.w+=vdmpy(Vuu.h,Rt.h):sat	HVX_Vector Q6_Vw_vdmpyacc_VwVhRh_sat (HVX_Vector Vx, HVX_VectorPair Vuu, Word32 Rt)
Vx.w+=vdmpy(Vuu.h,Rt.uh,#1):sat	HVX_Vector Q6_Vw_vdmpyacc_VwVhRuh_sat (HVX_Vector Vx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.h+=vdmpy(Vuu.ub,Rt.b)	HVX_VectorPair Q6_Wh_vdmpyacc_WhWubRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.w+=vdmpy(Vuu.h,Rt.b)	HVX_VectorPair Q6_Ww_vdmpyacc_WwWhRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)

Encoding

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	
ICLASS																t5				Parse		u5					d5					
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd.h=vdmpy(Vuu.ub,Rt.b)
ICLASS																t5				Parse		u5					x5					
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	Vxx.h+=vdmpy(Vuu.ub,Rt.b)
ICLASS																t5				Parse		u5					d5					
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vdmpy(Vu.h,Rt.uh):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.w=vdmpy(Vuu.h,Rt.uh,#1):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.w=vdmpy(Vu.h,Rt.h):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.w=vdmpy(Vuu.h,Rt.h):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.w=vdmpy(Vuu.h,Rt.b)
ICLASS																t5				Parse		u5					x5					
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vx.w+=vdmpy(Vu.h,Rt.uh):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vx.w+=vdmpy(Vuu.h,Rt.uh,#1):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	Vx.w+=vdmpy(Vuu.h,Rt.h):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	Vx.w+=vdmpy(Vu.h,Rt.h):sat
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	Vxx.w+=vdmpy(Vuu.h,Rt.b)
ICLASS																Parse				u5					d5							
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.w=vdmpy(Vu.h,Vv.h):sat
ICLASS																Parse				u5					x5							
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	Vx.w+=vdmpy(Vu.h,Vv.h):sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Lookup table for piecewise from 64-bit scalar

The vlut4 instruction implements a four-entry lookup table that is specified in scalar register pair Rtt.

Syntax

```
Vd.h=vlut4(Vu.uh,Rtt.h)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i]= Rtt.h[((Vu.h[i]>>14)&0x3)] ;
}
```

Class: COPROC_VX (slots 2)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vd.h=vlut4(Vu.uh,Rtt.h)
```

```
HVX_Vector Q6_Vh_vlut4_VuhPh(HVX_Vector Vu,
Word64 Rtt)
```

Encoding

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	
ICLASS												t5					Parse		u5					d5								
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.h=vlut4(Vu.uh,Rtt.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u

Multiply with piecewise add/sub from 64-bit scalar

Instructions to help nonlinear function calculations.

Syntax

```
Vx.h=vmpa(Vx.h,Vu.h,Rtt.h):sat
```

```
Vx.h=vmpa(Vx.h,Vu.uh,Rtt.uh):sat
```

```
Vx.h=vmps(Vx.h,Vu.uh,Rtt.uh):sat
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vx.h[i] = sat_16(( (Vx.h[i] * Vu.h[i]) << 1)
+ (Rtt.h[(Vu.h[i] >> 14) & 0x3] << 15) >> 16);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vx.h[i] = sat_16((Vx.h[i] * Vu.uh[i]) +
(Rtt.uh[(Vu.uh[i] >> 14) & 0x3] << 15) >> 16);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vx.h[i] = sat_16((Vx.h[i] * Vu.uh[i]) -
(Rtt.uh[(Vu.uh[i] >> 14) & 0x3] << 15) >> 16);
}
```

Class: COPROC_VX (slots 2)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vx.h=vmpa(Vx.h,Vu.h,Rtt.h):sat
```

```
HVX_Vector Q6_Vh_vmpa_VhVhVhPh_sat(HVX_Vector
Vx, HVX_Vector Vu, Word64 Rtt)
```

```
Vx.h=vmpa(Vx.h,Vu.uh,Rtt.uh):sat
```

```
HVX_Vector Q6_Vh_vmpa_VhVhVuhPuh_sat(HVX_Vector
Vx, HVX_Vector Vu, Word64 Rtt)
```

```
Vx.h=vmps(Vx.h,Vu.uh,Rtt.uh):sat
```

```
HVX_Vector Q6_Vh_vmps_VhVhVuhPuh_sat(HVX_Vector
Vx, HVX_Vector Vu, Word64 Rtt)
```

Encoding

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	
ICLASS												t5				Parse				u5				x5								
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	Vx.h=vmpa(Vx.h,Vu.h,Rtt.h):sat
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vx.h=vmpa(Vx.h,Vu.uh,Rtt.uh):sat
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x	Vx.h=vmps(Vx.h,Vu.uh,Rtt.uh):sat

Field name

ICLASS

Parse

Description

Instruction class

Packet/loop parse bits

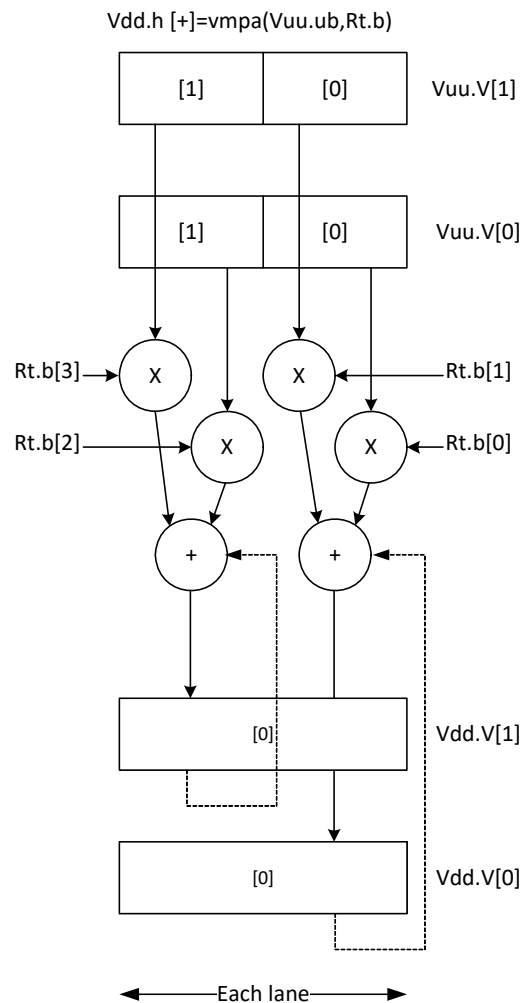
Field name	Description
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

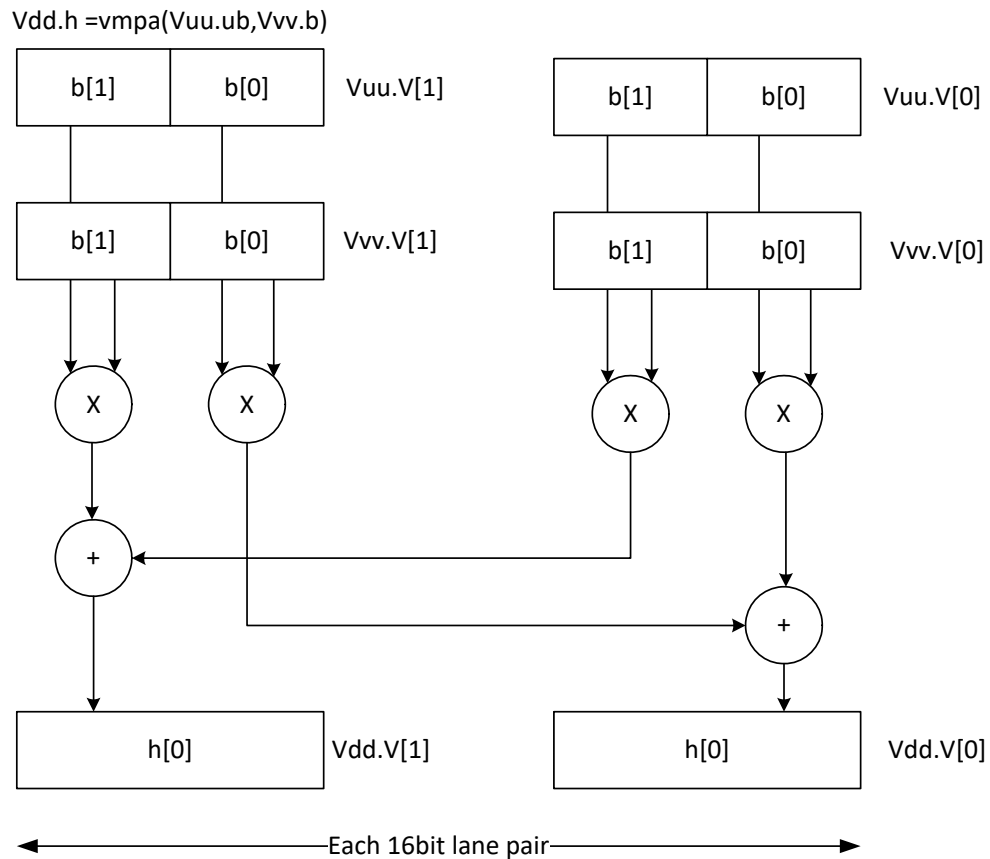
Multiply - add

Compute the sum of two byte multiplies. The two products consist of either unsigned bytes or signed halfwords coming from the vector registers V_{uu} and V_{vv} . These are multiplied by a signed byte coming from a scalar register R_t . The result of the summation is a signed halfword or word. Each corresponding pair of elements in V_{uu} and V_{vv} is weighted, using $R_t.b[0]$ and $R_t.b[1]$ for the even elements, and $R_t.b[2]$ and $R_t.b[3]$ for the odd elements.

Optionally accumulates the product with the destination vector register V_{xx} .

For vector by vector, compute the sum of two byte multiplies. The two products consist of an unsigned byte vector operand multiplied by a signed byte scalar. The result of the summation is a signed halfword. Even elements from the input vector register pairs V_{uu} and V_{vv} are multiplied together and placed in the even register of V_{dd} . Odd elements are placed in the odd register of V_{dd} .



**Syntax**

```
Vdd.h=vmpa (Vuu.ub, Rt.b)
```

```
Vdd.h=vmpa (Vuu.ub, Rt.ub)
```

```
Vdd.h=vmpa (Vuu.ub, Vvv.b)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = (Vuu.v[0].uh[i].ub[0] *
Rt.b[0]) + (Vuu.v[1].uh[i].ub[0] * Rt.b[1]);
    Vdd.v[1].h[i] = (Vuu.v[0].uh[i].ub[1] *
Rt.b[2]) + (Vuu.v[1].uh[i].ub[1] * Rt.b[3]);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].uh[i] = (Vuu.v[0].uh[i].ub[0] *
Rt.ub[0]) + (Vuu.v[1].uh[i].ub[0] * Rt.ub[1]);
    Vdd.v[1].uh[i] = (Vuu.v[0].uh[i].ub[1] *
Rt.ub[2]) + (Vuu.v[1].uh[i].ub[1] * Rt.ub[3]);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = (Vuu.v[0].uh[i].ub[0] *
Vvv.v[0].uh[i].b[0]) + (Vuu.v[1].uh[i].ub[0] *
Vvv.v[1].uh[i].b[0]);
    Vdd.v[1].h[i] = (Vuu.v[0].uh[i].ub[1] *
Vvv.v[0].uh[i].b[1]) + (Vuu.v[1].uh[i].ub[1] *
Vvv.v[1].uh[i].b[1]);
}
```

Syntax	Behavior
<code>Vdd.h=vmpa (Vuu.ub, Vvv.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].h[i] = (Vuu.v[0].uh[i].ub[0] * Vvv.v[0].uh[i].ub[0]) + (Vuu.v[1].uh[i].ub[0] * Vvv.v[1].uh[i].ub[0]); Vdd.v[1].h[i] = (Vuu.v[0].uh[i].ub[1] * Vvv.v[0].uh[i].ub[1]) + (Vuu.v[1].uh[i].ub[1] * Vvv.v[1].uh[i].ub[1]); }</pre>
<code>Vdd.w=vmpa (Vuu.h, Rt.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vuu.v[0].w[i].h[0] * Rt.b[0]) + (Vuu.v[1].w[i].h[0] * Rt.b[1]); Vdd.v[1].w[i] = (Vuu.v[0].w[i].h[1] * Rt.b[2]) + (Vuu.v[1].w[i].h[1] * Rt.b[3]); }</pre>
<code>Vdd.w=vmpa (Vuu.uh, Rt.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vuu.v[0].w[i].uh[0] * Rt.b[0]) + (Vuu.v[1].w[i].uh[0] * Rt.b[1]); Vdd.v[1].w[i] = (Vuu.v[0].w[i].uh[1] * Rt.b[2]) + (Vuu.v[1].w[i].uh[1] * Rt.b[3]); }</pre>
<code>Vxx.h+=vmpa (Vuu.ub, Rt.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vuu.v[0].uh[i].ub[0] * Rt.b[0]) + (Vuu.v[1].uh[i].ub[0] * Rt.b[1]); Vxx.v[1].h[i] += (Vuu.v[0].uh[i].ub[1] * Rt.b[2]) + (Vuu.v[1].uh[i].ub[1] * Rt.b[3]); }</pre>
<code>Vxx.h+=vmpa (Vuu.ub, Rt.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].uh[i] += (Vuu.v[0].uh[i].ub[0] * Rt.ub[0]) + (Vuu.v[1].uh[i].ub[0] * Rt.ub[1]); Vxx.v[1].uh[i] += (Vuu.v[0].uh[i].ub[1] * Rt.ub[2]) + (Vuu.v[1].uh[i].ub[1] * Rt.ub[3]); }</pre>
<code>Vxx.w+=vmpa (Vuu.h, Rt.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += (Vuu.v[0].w[i].h[0] * Rt.b[0]) + (Vuu.v[1].w[i].h[0] * Rt.b[1]); Vxx.v[1].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[2]) + (Vuu.v[1].w[i].h[1] * Rt.b[3]); }</pre>
<code>Vxx.w+=vmpa (Vuu.uh, Rt.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += (Vuu.v[0].w[i].uh[0] * Rt.b[0]) + (Vuu.v[1].w[i].uh[0] * Rt.b[1]); Vxx.v[1].w[i] += (Vuu.v[0].w[i].uh[1] * Rt.b[2]) + (Vuu.v[1].w[i].uh[1] * Rt.b[3]); }</pre>

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

Vdd.h=vmpa (Vuu.ub,Rt.b)	HVX_VectorPair Q6_Wh_vmpa_WubRb (HVX_VectorPair Vuu, Word32 Rt)
Vdd.h=vmpa (Vuu.ub,Rt.ub)	HVX_VectorPair Q6_Wh_vmpa_WubRub (HVX_VectorPair Vuu, Word32 Rt)
Vdd.h=vmpa (Vuu.ub,Vvv.b)	HVX_VectorPair Q6_Wh_vmpa_WubWb (HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.h=vmpa (Vuu.ub,Vvv.ub)	HVX_VectorPair Q6_Wh_vmpa_WubWub (HVX_VectorPair Vuu, HVX_VectorPair Vvv)
Vdd.w=vmpa (Vuu.h,Rt.b)	HVX_VectorPair Q6_Ww_vmpa_WhRb (HVX_VectorPair Vuu, Word32 Rt)
Vdd.w=vmpa (Vuu.uh,Rt.b)	HVX_VectorPair Q6_Ww_vmpa_WuRb (HVX_VectorPair Vuu, Word32 Rt)
Vxx.h+=vmpa (Vuu.ub,Rt.b)	HVX_VectorPair Q6_Wh_vmpaacc_WhWubRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.h+=vmpa (Vuu.ub,Rt.ub)	HVX_VectorPair Q6_Wh_vmpaacc_WhWubRub (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.w+=vmpa (Vuu.h,Rt.b)	HVX_VectorPair Q6_Ww_vmpaacc_WwWhRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.w+=vmpa (Vuu.uh,Rt.b)	HVX_VectorPair Q6_Ww_vmpaacc_WwWuRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)

Encoding

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		
ICLASS											t5					Parse		u5					d5										
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d		Vdd.h=vmpa(Vuu.ub,Rt.b)	
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d		Vdd.w=vmpa(Vuu.h,Rt.b)	
ICLASS											t5					Parse		u5					x5										
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x		Vxx.h+=vmpa(Vuu.ub,Rt.b)
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x		Vxx.w+=vmpa(Vuu.h,Rt.b)
ICLASS											t5					Parse		u5					d5										
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d		Vdd.h=vmpa(Vuu.ub,Rt.ub)	
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d		Vdd.w=vmpa(Vuu.uh,Rt.b)	
ICLASS											t5					Parse		u5					x5										
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x		Vxx.w+=vmpa(Vuu.uh,Rt.b)
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x		Vxx.h+=vmpa(Vuu.ub,Rt.ub)
ICLASS											t5					Parse		u5					d5										
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d		Vdd.h=vmpa(Vuu.ub,Vvv.b)	
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d		Vdd.h=vmpa(Vuu.ub,Vvv.ub)	

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

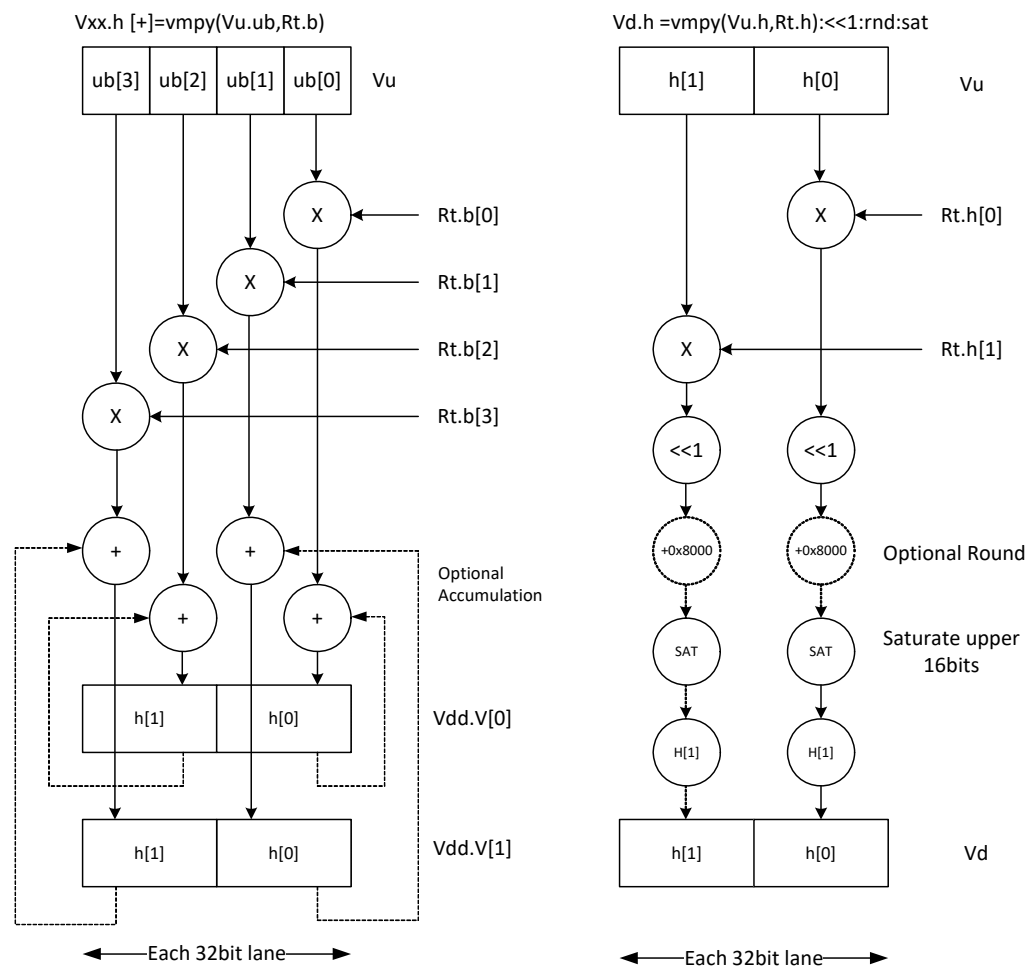
Multiply - vector by scalar

Multiply groups of elements in the vector Vu by the corresponding elements in the scalar register Rt .

This operation has two forms. In the first form the product is not modified, and is optionally accumulated with the destination register. The even results are placed in the even vector register of the destination register pair, while the odd results are placed in the odd vector register.

Supports signed by signed halfword, unsigned by unsigned byte, unsigned by signed byte, and unsigned halfword by unsigned halfword.

The second form of this operation keeps the output precision the same as the input width by shifting the product left by 1, saturating the product to 32 bits, and placing the upper 16 bits in the output. Optional rounding of the result is supported.



Syntax	Behavior
<code>Vd.h=vmpy(Vu.h,Rt.h):<<1:rnd:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i].h[0]=sat_16(sat_32(round(((Vu.w[i].h [0] * Rt.h[0])<<1))).h[1]); Vd.w[i].h[1]=sat_16(sat_32(round(((Vu.w[i].h [1] * Rt.h[1])<<1))).h[1]); }</pre>
<code>Vd.h=vmpy(Vu.h,Rt.h):<<1:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i].h[0]=sat_16(sat_32(((Vu.w[i].h[0] * Rt.h[0])<<1)).h[1]); Vd.w[i].h[1]=sat_16(sat_32(((Vu.w[i].h[1] * Rt.h[1])<<1)).h[1]); }</pre>
<code>Vdd.h=vmpy(Vu.ub,Rt.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].h[i] = (Vu.uh[i].ub[0] * Rt.b[(2*i+0)%4]); Vdd.v[1].h[i] = (Vu.uh[i].ub[1] * Rt.b[(2*i+1)%4]); }</pre>
<code>Vdd.uh=vmpy(Vu.ub,Rt.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].uh[i] = (Vu.uh[i].ub[0] * Rt.ub[(2*i+0)%4]); Vdd.v[1].uh[i] = (Vu.uh[i].ub[1] * Rt.ub[(2*i+1)%4]); }</pre>
<code>Vdd.uw=vmpy(Vu.uh,Rt.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].uw[i] = (Vu.uw[i].uh[0] * Rt.uh[0]); Vdd.v[1].uw[i] = (Vu.uw[i].uh[1] * Rt.uh[1]); }</pre>
<code>Vdd.w=vmpy(Vu.h,Rt.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vu.w[i].h[0] * Rt.h[0]); Vdd.v[1].w[i] = (Vu.w[i].h[1] * Rt.h[1]); }</pre>
<code>Vxx.h+=vmpy(Vu.ub,Rt.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vu.uh[i].ub[0] * Rt.b[(2*i+0)%4]); Vxx.v[1].h[i] += (Vu.uh[i].ub[1] * Rt.b[(2*i+1)%4]); }</pre>
<code>Vxx.uh+=vmpy(Vu.ub,Rt.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].uh[i] += (Vu.uh[i].ub[0] * Rt.ub[(2*i+0)%4]); Vxx.v[1].uh[i] += (Vu.uh[i].ub[1] * Rt.ub[(2*i+1)%4]); }</pre>
<code>Vxx.uw+=vmpy(Vu.uh,Rt.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].uw[i] += (Vu.uw[i].uh[0] * Rt.uh[0]); Vxx.v[1].uw[i] += (Vu.uw[i].uh[1] * Rt.uh[1]); }</pre>

Syntax	Behavior
<code>Vxx.w+=vmpy(Vu.h,Rt.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] = Vxx.v[0].w[i].s64 + (Vu.w[i].h[0] * Rt.h[0]); Vxx.v[1].w[i] = Vxx.v[1].w[i].s64 + (Vu.w[i].h[1] * Rt.h[1]); }</pre>
<code>Vxx.w+=vmpy(Vu.h,Rt.h):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] = sat_32(Vxx.v[0].w[i].s64 + (Vu.w[i].h[0] * Rt.h[0])); Vxx.v[1].w[i] = sat_32(Vxx.v[1].w[i].s64 + (Vu.w[i].h[1] * Rt.h[1])); }</pre>

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

<code>Vd.h=vmpy(Vu.h,Rt.h):<<1:rnd:sat</code>	HVX_Vector Q6_Vh_vmpy_VhRh_s1_rnd_sat(HVX_Vector Vu, Word32 Rt)
<code>Vd.h=vmpy(Vu.h,Rt.h):<<1:sat</code>	HVX_Vector Q6_Vh_vmpy_VhRh_s1_sat(HVX_Vector Vu, Word32 Rt)
<code>Vdd.h=vmpy(Vu.ub,Rt.b)</code>	HVX_VectorPair Q6_Wh_vmpy_VubRb(HVX_Vector Vu, Word32 Rt)
<code>Vdd.uh=vmpy(Vu.ub,Rt.ub)</code>	HVX_VectorPair Q6_Wuh_vmpy_VubRub(HVX_Vector Vu, Word32 Rt)
<code>Vdd.uw=vmpy(Vu.uh,Rt.uh)</code>	HVX_VectorPair Q6_Wuw_vmpy_VuhRuh(HVX_Vector Vu, Word32 Rt)
<code>Vdd.w=vmpy(Vu.h,Rt.h)</code>	HVX_VectorPair Q6_Ww_vmpy_VhRh(HVX_Vector Vu, Word32 Rt)
<code>Vxx.h+=vmpy(Vu.ub,Rt.b)</code>	HVX_VectorPair Q6_Wh_vmpyacc_WhVubRb(HVX_VectorPair Vxx, HVX_Vector Vu, Word32 Rt)
<code>Vxx.uh+=vmpy(Vu.ub,Rt.ub)</code>	HVX_VectorPair Q6_Wuh_vmpyacc_WuhVubRub(HVX_VectorPair Vxx, HVX_Vector Vu, Word32 Rt)
<code>Vxx.uw+=vmpy(Vu.uh,Rt.uh)</code>	HVX_VectorPair Q6_Wuw_vmpyacc_WuwVuhRuh(HVX_VectorPair Vxx, HVX_Vector Vu, Word32 Rt)
<code>Vxx.w+=vmpy(Vu.h,Rt.h)</code>	HVX_VectorPair Q6_Ww_vmpyacc_WwVhRh(HVX_VectorPair Vxx, HVX_Vector Vu, Word32 Rt)
<code>Vxx.w+=vmpy(Vu.h,Rt.h):sat</code>	HVX_VectorPair Q6_Ww_vmpyacc_WwVhRh_sat(HVX_VectorPair Vxx, HVX_Vector Vu, Word32 Rt)

Encoding

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	
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.h=vmpy(Vu.ub,Rt.b)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vxx.h+=vmpy(Vu.ub,Rt.b)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.w=vmpy(Vu.h,Rt.h)
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.h=vmpy(Vu.h,Rt.h):<<1:sat
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.h=vmpy(Vu.h,Rt.h):<<1:rnd:sat
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd.uw=vmpy(Vu.uh,Rt.uh)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vxx.w+=vmpy(Vu.h,Rt.h):sat
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vxx.uw+=vmpy(Vu.uh,Rt.uh)
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vxx.uh+=vmpy(Vu.ub,Rt.ub)
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x	Vxx.w+=vmpy(Vu.h,Rt.h)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	1	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.uh=vmpy(Vu.ub,Rt.ub)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

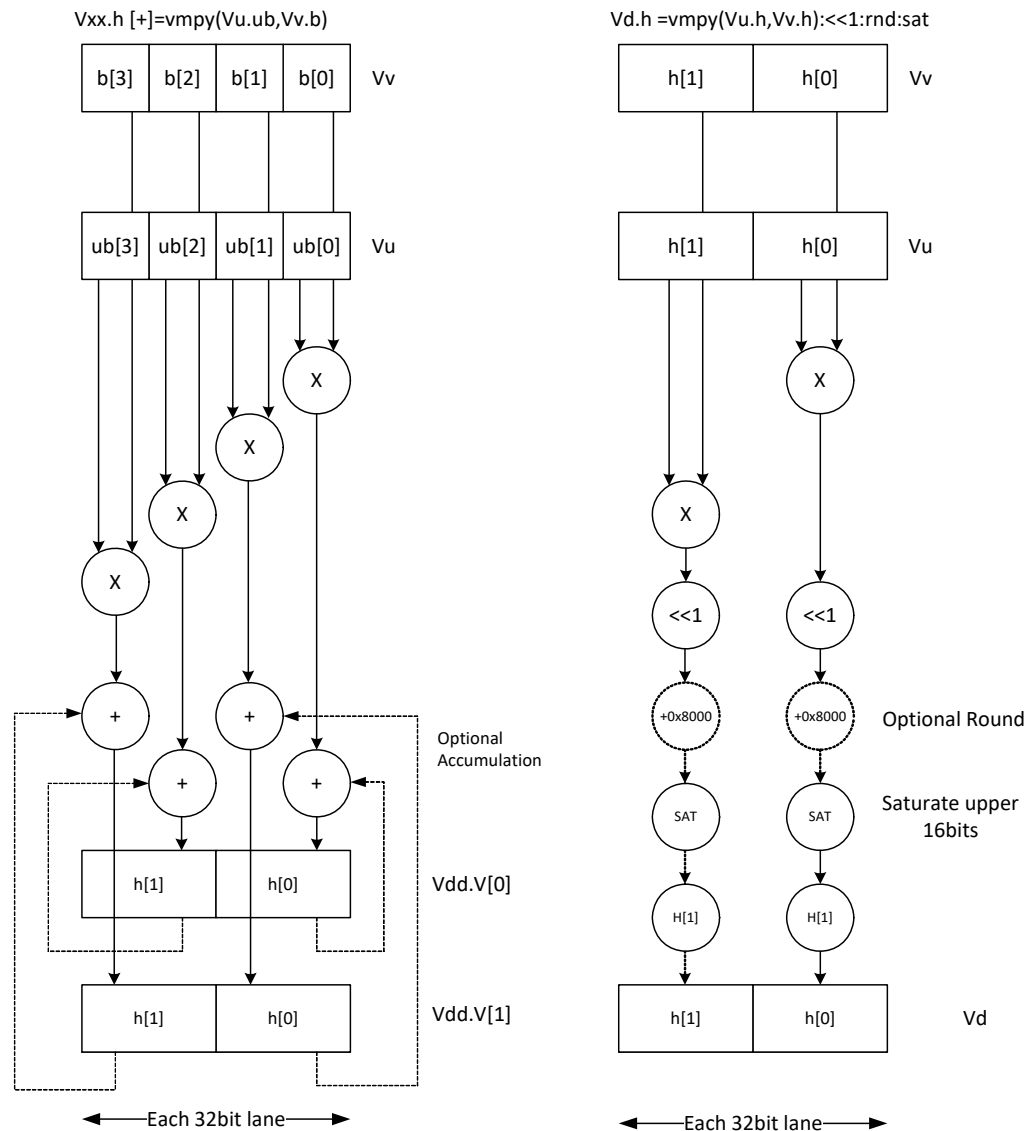
Multiply - vector by vector

Multiply groups of elements in the vector V_u by the corresponding elements in the vector register V_v .

This operation has two forms. In the first form the product is not modified, and is optionally accumulated with the destination register. The even results are placed in the even vector register of the destination register pair, while the odd results are placed in the odd vector register.

Supports signed by signed halfword, unsigned by unsigned byte, unsigned by signed byte, and unsigned halfword by unsigned halfword.

The second form of this operation keeps the output precision the same as the input width by shifting the product left by 1, saturating the product to 32 bits, and placing the upper 16 bits in the output.

**Syntax**

```
Vd.h=vmpy(Vu.h,Vv.h)<<1:rnd:sat
```

```
Vdd.h=vmpy(Vu.b,Vv.b)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = sat_16(sat_32(round((Vu.h[i] *
    Vv.h[i])<<1)).h[1]) );
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = (Vu.h[i].b[0] *
    Vv.h[i].b[0]);
    Vdd.v[1].h[i] = (Vu.h[i].b[1] *
    Vv.h[i].b[1]) ;
}
```

Syntax	Behavior
<code>Vdd.h=vmpy (Vu.ub, Vv.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].h[i] = (Vu.ub[i].ub[0] * Vv.h[i].b[0]); Vdd.v[1].h[i] = (Vu.ub[i].ub[1] * Vv.h[i].b[1]) ; }</pre>
<code>Vdd.uh=vmpy (Vu.ub, Vv.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vdd.v[0].uh[i] = (Vu.ub[i].ub[0] * Vv.uh[i].ub[0]); Vdd.v[1].uh[i] = (Vu.ub[i].ub[1] * Vv.uh[i].ub[1]) ; }</pre>
<code>Vdd.uw=vmpy (Vu.uh, Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].uw[i] = (Vu.uh[i].uh[0] * Vv.uw[i].uh[0]); Vdd.v[1].uw[i] = (Vu.uh[i].uh[1] * Vv.uw[i].uh[1]) ; }</pre>
<code>Vdd.w=vmpy (Vu.h, Vv.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vu.w[i].h[0] * Vv.w[i].h[0]); Vdd.v[1].w[i] = (Vu.w[i].h[1] * Vv.w[i].h[1]) ; }</pre>
<code>Vdd.w=vmpy (Vu.h, Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vu.w[i].h[0] * Vv.uw[i].uh[0]); Vdd.v[1].w[i] = (Vu.w[i].h[1] * Vv.uw[i].uh[1]) ; }</pre>
<code>Vxx.h+=vmpy (Vu.b, Vv.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vu.h[i].b[0] * Vv.h[i].b[0]); Vxx.v[1].h[i] += (Vu.h[i].b[1] * Vv.h[i].b[1]) ; }</pre>
<code>Vxx.h+=vmpy (Vu.ub, Vv.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vu.ub[i].ub[0] * Vv.h[i].b[0]); Vxx.v[1].h[i] += (Vu.ub[i].ub[1] * Vv.h[i].b[1]) ; }</pre>
<code>Vxx.uh+=vmpy (Vu.ub, Vv.ub)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vxx.v[0].uh[i] += (Vu.ub[i].ub[0] * Vv.uh[i].ub[0]); Vxx.v[1].uh[i] += (Vu.ub[i].ub[1] * Vv.uh[i].ub[1]) ; }</pre>
<code>Vxx.uw+=vmpy (Vu.uh, Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].uw[i] += (Vu.uw[i].uh[0] * Vv.uw[i].uh[0]); Vxx.v[1].uw[i] += (Vu.uw[i].uh[1] * Vv.uw[i].uh[1]) ; }</pre>

Syntax	Behavior
<code>Vxx.w+=vmpy(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += (Vu.w[i].h[0] * Vv.w[i].h[0]); Vxx.v[1].w[i] += (Vu.w[i].h[1] * Vv.w[i].h[1]) ; }</pre>
<code>Vxx.w+=vmpy(Vu.h,Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += (Vu.w[i].h[0] * Vv.uw[i].uh[0]); Vxx.v[1].w[i] += (Vu.w[i].h[1] * Vv.uw[i].uh[1]) ; }</pre>

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

<code>Vd.h=vmpy(Vu.h,Vv.h) :<<1:rnd:sat</code>	<code>HVX_Vector Q6_Vh_vmpy_VhVh_s1_rnd_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vdd.h=vmpy(Vu.b,Vv.b)</code>	<code>HVX_VectorPair Q6_Wh_vmpy_VbVb(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vdd.h=vmpy(Vu.ub,Vv.b)</code>	<code>HVX_VectorPair Q6_Wh_vmpy_VubVb(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vdd.uh=vmpy(Vu.ub,Vv.ub)</code>	<code>HVX_VectorPair Q6_Wuh_vmpy_VubVub(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vdd.uw=vmpy(Vu.uh,Vv.uh)</code>	<code>HVX_VectorPair Q6_Wuw_vmpy_VuhVuh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vdd.w=vmpy(Vu.h,Vv.h)</code>	<code>HVX_VectorPair Q6_Ww_vmpy_VhVh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vdd.w=vmpy(Vu.h,Vv.uh)</code>	<code>HVX_VectorPair Q6_Ww_vmpy_VhVuh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vxx.h+=vmpy(Vu.b,Vv.b)</code>	<code>HVX_VectorPair Q6_Wh_vmpyacc_WhVbVb(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vxx.h+=vmpy(Vu.ub,Vv.b)</code>	<code>HVX_VectorPair Q6_Wh_vmpyacc_WhVubVb(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vxx.uh+=vmpy(Vu.ub,Vv.ub)</code>	<code>HVX_VectorPair Q6_Wuh_vmpyacc_WuhVubVub(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vxx.uw+=vmpy(Vu.uh,Vv.uh)</code>	<code>HVX_VectorPair Q6_Wuw_vmpyacc_WuwVuhVuh(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vxx.w+=vmpy(Vu.h,Vv.h)</code>	<code>HVX_VectorPair Q6_Ww_vmpyacc_WwVhVh(HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv)</code>

Vxx.w+=vmpy(Vu.h, Vv.uh)

```
HVX_VectorPair
Q6_Ww_vmpyacc_WwVhVuh(HVX_VectorPair Vxx,
HVX_Vector Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.h=vmpy(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.uh=vmpy(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.h=vmpy(Vu.ub,Vv.b)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd.w=vmpy(Vu.h,Vv.h)
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	Vxx.h+=vmpy(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vxx.uh+=vmpy(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x	Vxx.h+=vmpy(Vu.ub,Vv.b)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	Vxx.w+=vmpy(Vu.h,Vv.h)
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.uw=vmpy(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.h=vmpy(Vu.h,Vv.h):<<1:rnd:sat
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vdd.w=vmpy(Vu.h,Vv.uh)
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vxx.uw+=vmpy(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vxx.w+=vmpy(Vu.h,Vv.uh)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Multiply - half precision vector by vector

Half precision (16-bit) multiply.

Syntax	Behavior
<code>Vd.qf16=vmpy(Vu.hf,Vv.hf)</code>	<pre>for (i = 0; i < VELEM(16); i++) { u = Vu.hf[i]; v = Vv.hf[i]; Vd.qf16[i] = rnd_sat(u.exp+v.exp,u.sig*v.sig,0); if(u.sign^v.sign) Vd.qf16[i] = -(Vd.qf16[i]); }</pre>
<code>Vd.qf16=vmpy(Vu.qf16,Vv.hf)</code>	<pre>for (i = 0; i < VELEM(16); i++) { u = Vu.qf16[i]; v = Vv.hf[i]; Vd.qf16[i] = rnd_sat(u.exp+v.exp,u.sig*v.sig,0); if(v.sign) Vd.qf16[i] = -(Vd.qf16[i]); }</pre>
<code>Vd.qf16=vmpy(Vu.qf16,Vv.qf16)</code>	<pre>for (i = 0; i < VELEM(16); i++) { u = Vu.qf16[i]; v = Vv.qf16[i]; Vd.qf16[i] = rnd_sat(u.exp+v.exp,u.sig*v.sig,0); }</pre>
<code>Vdd.qf32=vmpy(Vu.hf,Vv.hf)</code>	<pre>for (i = 0; i < VELEM(32); i++) { u0 = Vu.w[i] & 0xFFFF; u1 = (Vu.w[i]>>16) & 0xFFFF; v0 = Vv.w[i] & 0xFFFF; v1 = (Vv.w[i]>>16) & 0xFFFF; Vdd.v[0].qf32[i] = rnd_sat(u0.exp+v0.exp,u0.sig*v0.sig,0); Vdd.v[1].qf32[i] = rnd_sat(u1.exp+v1.exp,u1.sig*v1.sig,0); if(u0.sign^v0.sign) Vdd.v[0].qf32[i] = - (Vdd.v[0].qf32[i]); if(u1.sign^v1.sign) Vdd.v[1].qf32[i] = - (Vdd.v[1].qf32[i]); }</pre>
<code>Vdd.qf32=vmpy(Vu.qf16,Vv.hf)</code>	<pre>for (i = 0; i < VELEM(32); i++) { u0 = Vu.w[i] & 0xFFFF; u1 = (Vu.w[i]>>16) & 0xFFFF; v0 = Vv.w[i] & 0xFFFF; v1 = (Vv.w[i]>>16) & 0xFFFF; Vdd.v[0].qf32[i] = rnd_sat(u0.exp+v0.exp,u0.sig*v0.sig,0); Vdd.v[1].qf32[i] = rnd_sat(u1.exp+v1.exp,u1.sig*v1.sig,0); if(v0.sign) Vdd.v[0].qf32[i] = - (Vdd.v[0].qf32[i]); if(v1.sign) Vdd.v[1].qf32[i] = - (Vdd.v[1].qf32[i]); }</pre>

Syntax

```
Vdd.qf32=vmpy(Vu.qf16,Vv.qf16)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    u0 = Vu.w[i] & 0xFFFF;
    u1 = (Vu.w[i]>>16) & 0xFFFF;
    v0 = Vv.w[i] & 0xFFFF;
    v1 = (Vv.w[i]>>16) & 0xFFFF;
    Vdd.v[0].qf32[i] =
    rnd_sat(u0.exp+v0.exp,u0.sig*v0.sig,0);
    Vdd.v[1].qf32[i] =
    rnd_sat(u1.exp+v1.exp,u1.sig*v1.sig,0);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vd.qf16=vmpy(Vu.hf,Vv.hf)
```

```
HVX_Vector Q6_Vqf16_vmpy_VhfVhf (HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf16=vmpy(Vu.qf16,Vv.hf)
```

```
HVX_Vector Q6_Vqf16_vmpy_Vqf16Vhf (HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf16=vmpy(Vu.qf16,Vv.qf16)
```

```
HVX_Vector Q6_Vqf16_vmpy_Vqf16Vqf16 (HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vdd.qf32=vmpy(Vu.hf,Vv.hf)
```

```
HVX_VectorPair Q6_Wqf32_vmpy_VhfVhf (HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vdd.qf32=vmpy(Vu.qf16,Vv.hf)
```

```
HVX_VectorPair Q6_Wqf32_vmpy_Vqf16Vhf (HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vdd.qf32=vmpy(Vu.qf16,Vv.qf16)
```

```
HVX_VectorPair
Q6_Wqf32_vmpy_Vqf16Vqf16 (HVX_Vector Vu,
HVX_Vector Vv)
```

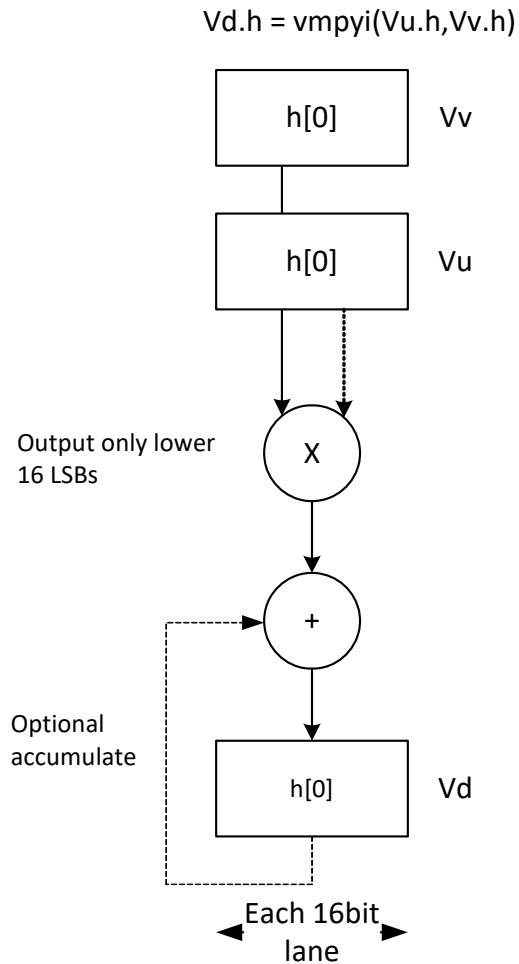
Encoding

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	
ICLASS																Parse				u5				d5								
0	0	0	1	1	1	1	1	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.qf32=vmpy(Vu.qf16,Vv.hf)
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.qf16=vmpy(Vu.qf16,Vv.qf16)
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.qf16=vmpy(Vu.hf,Vv.hf)
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.qf16=vmpy(Vu.qf16,Vv.hf)
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.qf32=vmpy(Vu.qf16,Vv.qf16)
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	d	d	d	d	d	Vdd.qf32=vmpy(Vu.hf,Vv.hf)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Integer multiply - vector by vector

Multiply corresponding elements in V_u by the corresponding elements in V_v , and place the lower half of the result in the destination vector register V_d . Supports signed halfwords, and optional accumulation of the product with the destination vector register V_x .



Syntax

```
Vd.h=vmpyi (Vu.h, Vv.h)
```

```
Vx.h+=vmpyi (Vu.h, Vv.h)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = (Vu.h[i] * Vv.h[i]) ;
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vx.h[i] += (Vu.h[i] * Vv.h[i]) ;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

`Vd.h=vmpyi (Vu.h,Vv.h)`

HVX_Vector Q6_Vh_vmpyi_VhVh (HVX_Vector Vu,
HVX_Vector Vv)

`Vx.h+=vmpyi (Vu.h,Vv.h)`

HVX_Vector Q6_Vh_vmpyiacc_VhVhVh (HVX_Vector Vx,
HVX_Vector Vu, HVX_Vector Vv)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.h=vmpyi(Vu.h,Vv.h)
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	Vx.h+=vmpyi(Vu.h,Vv.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Integer multiply (32x16)

Multiply words in one vector by even or odd halfwords in another vector. Take the lower part. Some versions of this operation perform unusual shifts to facilitate 32x32 multiply synthesis.

Syntax

`Vd.w=vmpyie(Vu.w,Vv.uh)`

`Vd.w=vmpyio(Vu.w,Vv.h)`

`Vx.w+=vmpyie(Vu.w,Vv.h)`

`Vx.w+=vmpyie(Vu.w,Vv.uh)`

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.w[i] * Vv.w[i].uh[0]);
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.w[i] * Vv.w[i].h[1]);
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] = Vx.w[i] + (Vu.w[i] *
    Vv.w[i].h[0]);
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] = Vx.w[i] + (Vu.w[i] *
    Vv.w[i].uh[0]);
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

`Vd.w=vmpyie(Vu.w,Vv.uh)`

HVX_Vector Q6_Vw_vmpyie_VwVuh(HVX_Vector Vu, HVX_Vector Vv)

`Vd.w=vmpyio(Vu.w,Vv.h)`

HVX_Vector Q6_Vw_vmpyio_VwVh(HVX_Vector Vu, HVX_Vector Vv)

`Vx.w+=vmpyie(Vu.w,Vv.h)`

HVX_Vector Q6_Vw_vmpyieacc_VwVwVh(HVX_Vector Vx, HVX_Vector Vu, HVX_Vector Vv)

`Vx.w+=vmpyie(Vu.w,Vv.uh)`

HVX_Vector Q6_Vw_vmpyieacc_VwVwVuh(HVX_Vector Vx, HVX_Vector Vu, HVX_Vector Vv)

Encoding

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	
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vx.w+=vmpyie(Vu.w,Vv.uh)
0	0	0	1	1	1	0	0	0	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vx.w+=vmpyie(Vu.w,Vv.h)
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vmpyie(Vu.w,Vv.uh)
0	0	0	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.w=vmpyio(Vu.w,Vv.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

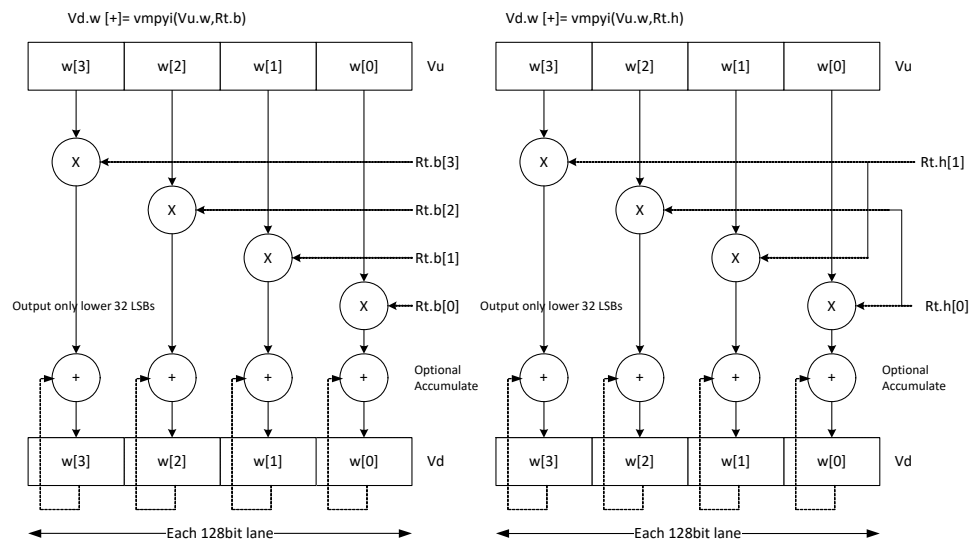
Integer multiply accumulate even/odd

Multiply groups of words in vector register Vu by the elements in Rt. The lower 32-bit results are placed in vector register Vd.

The operation has two forms:

- Signed words or halfwords in Vu
- Multiplied by signed bytes in Rt

Optionally accumulates the product with the destination vector register Vx.



Syntax

```
Vd.w=vmpyi (Vu.w, Rt.h)
```

```
Vx.w+=vmpyi (Vu.w, Rt.h)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.w[i] * Rt.h[i % 2]) ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] += (Vu.w[i] * Rt.h[i % 2]) ;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vd.w=vmpyi (Vu.w, Rt.h)
```

```
HVX_Vector Q6_Vw_vmpyi_VwRh(HVX_Vector Vu,
Word32 Rt)
```

```
Vx.w+=vmpyi (Vu.w, Rt.h)
```

```
HVX_Vector Q6_Vw_vmpyiacc_VwVwRh(HVX_Vector Vx,
HVX_Vector Vu, Word32 Rt)
```

Encoding

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	
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	Vx.w+=vmpyi(Vu.w,Rt.h)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.w+=vmpyi(Vu.w,Rt.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Multiply - single precision vector by vector

Single precision (32-bit) multiply.

Syntax

```
Vd.qf32=vmpy(Vu.qf32,Vv.qf32)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.qf32[i];
    v = Vv.qf32[i];
    Vd.qf32[i] =
    rnd_sat(u.exp+v.exp,u.sig*v.sig,0);
}
```

```
Vd.qf32=vmpy(Vu.sf,Vv.sf)
```

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.sf[i];
    v = Vv.sf[i];
    Vd.qf32[i] =
    rnd_sat(u.exp+v.exp,u.sig*v.sig,0);
    if(u.sign^v.sign) Vd.qf32[i] = -(Vd.qf32[i]);
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vd.qf32=vmpy(Vu.qf32,Vv.qf32)
```

```
HVX_Vector Q6_Vqf32_vmpy_Vqf32Vqf32 (HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vd.qf32=vmpy(Vu.sf,Vv.sf)
```

```
HVX_Vector Q6_Vqf32_vmpy_VsfVsf (HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

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		
ICLASS																Parse		u5					d5										
0	0	0	1	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.qf32=vmpy(Vu.qf32,Vv.qf32)
0	0	0	1	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.qf32=vmpy(Vu.sf,Vv.sf)

Field name

Description

ICLASS

Instruction class

Parse

Packet/loop parse bits

d5

Field to encode register d

u5

Field to encode register u

v5

Field to encode register v

Multiply (32x16)

Multiply words in one vector by even or odd halfwords in another vector. Take the upper part. Some versions of this operation perform specific shifts to facilitate 32x32 multiply synthesis.

An important operation is a 32 x 32 fractional multiply, equivalent to $(OP1 * OP2) \gg 31$. The case of $fn(0x80000000, 0x80000000)$ must saturate to $0x7fffffff$.

The rounding fractional multiply:

```
vectorize(sat_32(x*y+0x40000000)>>31))
```

equivalent to:

```
{V2 = vmpye(V0.w, V1.uh) }
{V2+= vmpyo(V0.w, V1.h) :<<1:rnd:sat:shift}
```

The nonrounding fractional multiply version:

```
vectorize(sat_32(x * y)>>31))
```

equivalent to:

```
{V2 = vmpye(V0.w, V1.uh) }
{V2+= vmpyo(V0.w, V1.h) :<<1:sat:shift}
```

Also a key function is a 32-bit x 32-bit signed multiply where the 64-bit result is kept.

```
vectorize((int64) x*(int64) y)
```

equivalent to:

```
{V3:2 = vmpye(V0.w, V1.uh) }
{V3:2+= vmpyo(V0.w, V1.h) }
```

The lower 32 bits of products are in V2 and the upper 32 bits in V3. If only `vmpye` is performed, the result is a 48-bit product of 32 signed x 16-bit unsigned asserted into the upper 48 bits of `Vdd`. If `vmpyo` only is performed assuming `Vxx = #0`, the result is a 32 signed x 16 signed product asserted into the upper 48 bits of `Vxx`.

Syntax	Behavior
<code>Vd.w=vmpye(Vu.w,Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i] * Vv.w[i].uh[0]) >> 16; }</pre>
<code>Vd.w=vmpyo(Vu.w,Vv.h) :<<1[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = sat_32((((Vu.w[i] * Vv.w[i].h[1]) >> 14) + 1) >> 1)); }</pre>
<code>Vdd=vmpye(Vu.w,Vv.uh)</code>	<pre>for (i = 0; i < VELEM(32); i++) { prod = (Vu.w[i] * Vv.w[i].uh[0]); Vdd.v[1].w[i] = prod >> 16; Vdd.v[0].w[i] = prod << 16; }</pre>

Syntax

```
Vx.w+=vmpyo(Vu.w,Vv.h):<<1[:rnd]
]:sat:shift
```

```
Vxx+=vmpyo(Vu.w,Vv.h)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] = sat_32((((Vx.w[i] + (Vu.w[i] *
Vv.w[i].h[1])) >> 14) + 1) >> 1));
}
```

```
for (i = 0; i < VELEM(32); i++) {
    prod = (Vu.w[i] * Vv.w[i].h[1]) +
Vxx.v[1].w[i];
    Vxx.v[1].w[i] = prod >> 16;
    Vxx.v[0].w[i].h[0]=Vxx.v[0].w[i] >> 16;
    Vxx.v[0].w[i].h[1]=prod & 0x000ffff;
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vd.w=vmpye(Vu.w,Vv.uh)
```

```
HVX_Vector Q6_Vw_vmpye_VwVuh(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.w=vmpyo(Vu.w,Vv.h):<<1:rnd:s
at
```

```
HVX_Vector
Q6_Vw_vmpyo_VwVh_s1_rnd_sat(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.w=vmpyo(Vu.w,Vv.h):<<1:sat
```

```
HVX_Vector Q6_Vw_vmpyo_VwVh_s1_sat(HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vdd=vmpye(Vu.w,Vv.uh)
```

```
HVX_VectorPair Q6_W_vmpye_VwVuh(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vx.w+=vmpyo(Vu.w,Vv.h):<<1:rnd:
sat:shift
```

```
HVX_Vector
Q6_Vw_vmpyoacc_VwVwVh_s1_rnd_sat_shift(HVX_Vecto
r Vx, HVX_Vector Vu, HVX_Vector Vv)
```

```
Vx.w+=vmpyo(Vu.w,Vv.h):<<1:sat:
shift
```

```
HVX_Vector
Q6_Vw_vmpyoacc_VwVwVh_s1_sat_shift(HVX_Vector
Vx, HVX_Vector Vu, HVX_Vector Vv)
```

```
Vxx+=vmpyo(Vu.w,Vv.h)
```

```
HVX_VectorPair
Q6_W_vmpyoacc_WVwVh(HVX_VectorPair Vxx,
HVX_Vector Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse				u5					x5							
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	Vxx+=vmpyo(Vu.w,Vv.h)
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x	Vx.w+=vmpyo(Vu.w,Vv.h):<<1:sat:shift
0	0	0	1	1	1	0	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	Vx.w+=vmpyo(Vu.w,Vv.h):<<1:rnd:sat:shift

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd=vmpye(Vu.w,Vv.uh)
0	0	0	1	1	1	1	1	0	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vmpyo(Vu.w,Vv.h):<<1:rnd:sat
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.w=vmpye(Vu.w,Vv.uh)
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.w=vmpyo(Vu.w,Vv.h):<<1:sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Multiply bytes with 4-wide reduction - vector by scalar

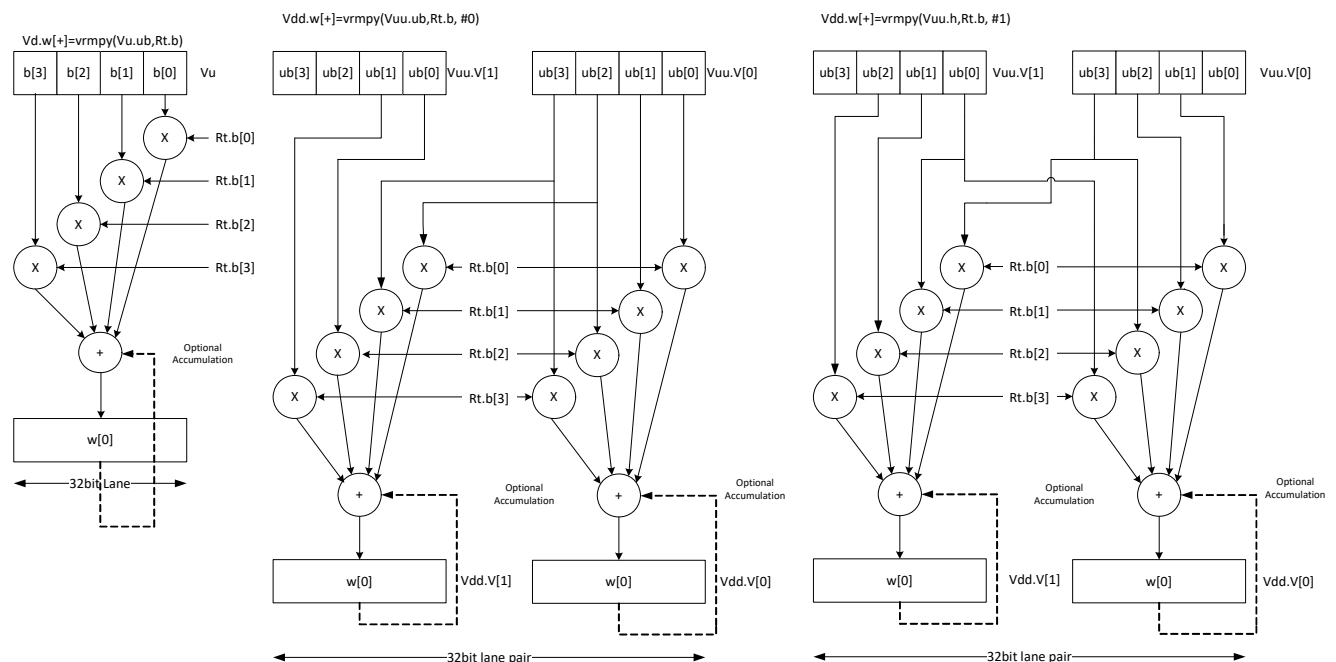
Perform multiplication between the elements in vector V_u and the corresponding elements in the scalar register R_t , followed by a 4-way reduction to a word in each 32-bit lane. Accumulate the result in V_x or V_{xx} .

Supports the multiplication of unsigned byte data by signed or unsigned bytes in the scalar.

The operation has two forms:

- The first form performs simple dot product of 4 elements into a single result
- The second form takes a 1 bit immediate input and generates a vector register pair

For $\#1 = 0$ the even destination contains a simple dot product, the odd destination contains a dot product of the coefficients rotated by two elements and the upper two data elements taken from the even register of V_{uu} . For $\#1 = 1$, the even destination takes coefficients rotated by -1 and data element 0 from the odd register of V_{uu} . The odd destination uses coefficients rotated by -1 and takes data element 3 from the even register of V_{uu} .



Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Syntax	Behavior
<pre>Vdd.uw=vrmpy (Vuu.ub, Rt.ub, #u1)</pre>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].uw[i] = (Vuu.v[#u ? 1:0].uw[i].ub[0] * Rt.ub[(0-#u) & 0x3]); Vdd.v[0].uw[i] += (Vuu.v[0].uw[i].ub[1] * Rt.ub[(1-#u) & 0x3]); Vdd.v[0].uw[i] += (Vuu.v[0].uw[i].ub[2] * Rt.ub[(2-#u) & 0x3]); Vdd.v[0].uw[i] += (Vuu.v[0].uw[i].ub[3] * Rt.ub[(3-#u) & 0x3]); Vdd.v[1].uw[i] = (Vuu.v[1].uw[i].ub[0] * Rt.ub[(2-#u) & 0x3]); Vdd.v[1].uw[i] += (Vuu.v[1].uw[i].ub[1] * Rt.ub[(3-#u) & 0x3]); Vdd.v[1].uw[i] += (Vuu.v[#u ? 1:0].uw[i].ub[2] * Rt.ub[(0-#u) & 0x3]); Vdd.v[1].uw[i] += (Vuu.v[0].uw[i].ub[3] * Rt.ub[(1-#u) & 0x3]) ; }</pre>
<pre>Vdd.w=vrmpy (Vuu.ub, Rt.b, #u1)</pre>	<pre>for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vuu.v[#u ? 1:0].uw[i].ub[0] * Rt.b[(0-#u) & 0x3]); Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[1] * Rt.b[(1-#u) & 0x3]); Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[2] * Rt.b[(2-#u) & 0x3]); Vdd.v[0].w[i] += (Vuu.v[0].uw[i].ub[3] * Rt.b[(3-#u) & 0x3]); Vdd.v[1].w[i] = (Vuu.v[1].uw[i].ub[0] * Rt.b[(2-#u) & 0x3]); Vdd.v[1].w[i] += (Vuu.v[1].uw[i].ub[1] * Rt.b[(3-#u) & 0x3]); Vdd.v[1].w[i] += (Vuu.v[#u ? 1:0].uw[i].ub[2] * Rt.b[(0-#u) & 0x3]); Vdd.v[1].w[i] += (Vuu.v[0].uw[i].ub[3] * Rt.b[(1-#u) & 0x3]) ; }</pre>
<pre>Vxx.uw+=vrmpy (Vuu.ub, Rt.ub, #u1)</pre>	<pre>for (i = 0; i < VELEM(32); i++) { Vxx.v[0].uw[i] += (Vuu.v[#u ? 1:0].uw[i].ub[0] * Rt.ub[(0-#u) & 0x3]); Vxx.v[0].uw[i] += (Vuu.v[0].uw[i].ub[1] * Rt.ub[(1-#u) & 0x3]); Vxx.v[0].uw[i] += (Vuu.v[0].uw[i].ub[2] * Rt.ub[(2-#u) & 0x3]); Vxx.v[0].uw[i] += (Vuu.v[0].uw[i].ub[3] * Rt.ub[(3-#u) & 0x3]); Vxx.v[1].uw[i] += (Vuu.v[1].uw[i].ub[0] * Rt.ub[(2-#u) & 0x3]); Vxx.v[1].uw[i] += (Vuu.v[1].uw[i].ub[1] * Rt.ub[(3-#u) & 0x3]); Vxx.v[1].uw[i] += (Vuu.v[#u ? 1:0].uw[i].ub[2] * Rt.ub[(0-#u) & 0x3]); Vxx.v[1].uw[i] += (Vuu.v[0].uw[i].ub[3] * Rt.ub[(1-#u) & 0x3]) ; }</pre>

Syntax

```
Vxx.w+=vrmpy(Vuu.ub,Rt.b,#u1)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vxx.v[0].w[i] += (Vuu.v[#u ?
1:0].ub[i].ub[0] * Rt.b[(0-#u) & 0x3]);
    Vxx.v[0].w[i] += (Vuu.v[0].ub[i].ub[1] *
Rt.b[(1-#u) & 0x3]);
    Vxx.v[0].w[i] += (Vuu.v[0].ub[i].ub[2] *
Rt.b[(2-#u) & 0x3]);
    Vxx.v[0].w[i] += (Vuu.v[0].ub[i].ub[3] *
Rt.b[(3-#u) & 0x3]);
    Vxx.v[1].w[i] += (Vuu.v[1].ub[i].ub[0] *
Rt.b[(2-#u) & 0x3]);
    Vxx.v[1].w[i] += (Vuu.v[1].ub[i].ub[1] *
Rt.b[(3-#u) & 0x3]);
    Vxx.v[1].w[i] += (Vuu.v[#u ?
1:0].ub[i].ub[2] * Rt.b[(0-#u) & 0x3]);
    Vxx.v[1].w[i] += (Vuu.v[0].ub[i].ub[3] *
Rt.b[(1-#u) & 0x3]);
}
```

Intrinsics

```
Vdd.uw=vrmpy(Vuu.ub,Rt.ub,#u1)
```

```
HVX_VectorPair
Q6_Wuw_vrmpy_WubRubI(HVX_VectorPair Vuu, Word32
Rt, Word32 Iu1)
```

```
Vdd.w=vrmpy(Vuu.ub,Rt.b,#u1)
```

```
HVX_VectorPair Q6_Ww_vrmpy_WubRbI(HVX_VectorPair
Vuu, Word32 Rt, Word32 Iu1)
```

```
Vxx.uw+=vrmpy(Vuu.ub,Rt.ub,#u1)
```

```
HVX_VectorPair
Q6_Wuw_vrmpyacc_WuwWubRubI(HVX_VectorPair Vxx,
HVX_VectorPair Vuu, Word32 Rt, Word32 Iu1)
```

```
Vxx.w+=vrmpy(Vuu.ub,Rt.b,#u1)
```

```
HVX_VectorPair
Q6_Ww_vrmpyacc_WwWubRbI(HVX_VectorPair Vxx,
HVX_VectorPair Vuu, Word32 Rt, Word32 Iu1)
```

Encoding

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	
ICLASS												t5				Parse		u5					d5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	i	d	d	d	d	d	Vdd.w=vrmpy(Vuu.ub,Rt.b,#u1)
ICLASS												t5				Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	i	x	x	x	x	x	Vxx.w+=vrmpy(Vuu.ub,Rt.b,#u1)
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	i	x	x	x	x	x	Vxx.uw+=vrmpy(Vuu.ub,Rt.ub,#u1)
ICLASS												t5				Parse		u5					d5									
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	i	d	d	d	d	d	Vdd.uw=vrmpy(Vuu.ub,Rt.ub,#u1)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d

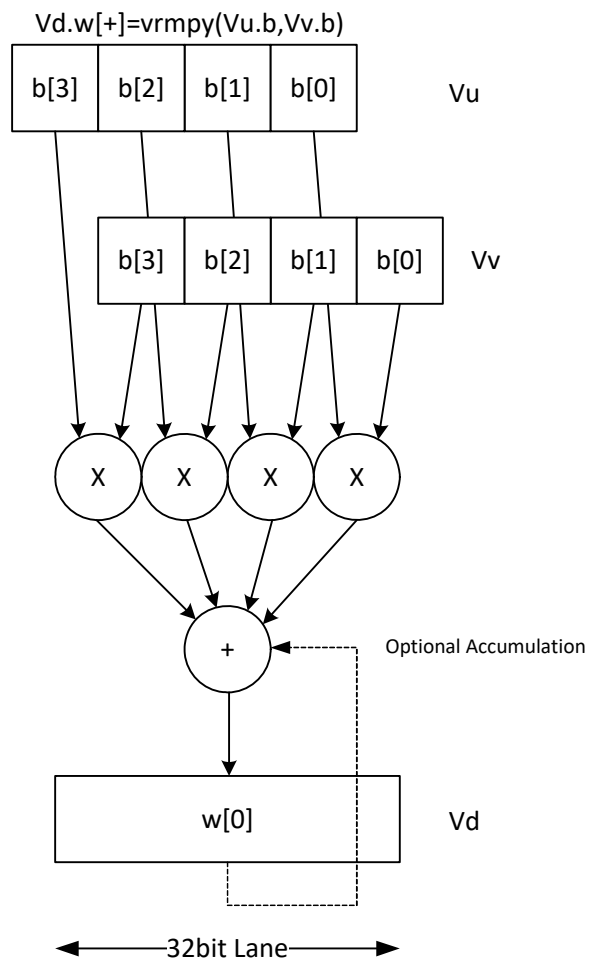
Field name	Description
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Multiply by byte with accumulate and 4-wide reduction - vector by vector

The `vrmpy` instruction performs a dot product function between four byte elements in vector register `Vu` and four byte elements in `Vv`. The sum of products can be optionally accumulated into `Vx` or written into `Vd` as words within each 32-bit lane.

Data types can be:

- unsigned by unsigned
- signed by signed
- unsigned by signed



Syntax

```
Vx.uw+=vrmpy (Vu.ub, Vv.ub)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vx.uw[i] += (Vu.uw[i].ub[0] *
Vv.uw[i].ub[0]);
    Vx.uw[i] += (Vu.uw[i].ub[1] *
Vv.uw[i].ub[1]);
    Vx.uw[i] += (Vu.uw[i].ub[2] *
Vv.uw[i].ub[2]);
    Vx.uw[i] += (Vu.uw[i].ub[3] *
Vv.uw[i].ub[3]);
}
```

```
Vx.w+=vrmpy (Vu.b, Vv.b)
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] += (Vu.w[i].b[0] * Vv.w[i].b[0]);
    Vx.w[i] += (Vu.w[i].b[1] * Vv.w[i].b[1]);
    Vx.w[i] += (Vu.w[i].b[2] * Vv.w[i].b[2]);
    Vx.w[i] += (Vu.w[i].b[3] * Vv.w[i].b[3]);
}
```

```
Vx.w+=vrmpy (Vu.ub, Vv.b)
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] += (Vu.uw[i].ub[0] * Vv.w[i].b[0]);
    Vx.w[i] += (Vu.uw[i].ub[1] * Vv.w[i].b[1]);
    Vx.w[i] += (Vu.uw[i].ub[2] * Vv.w[i].b[2]);
    Vx.w[i] += (Vu.uw[i].ub[3] * Vv.w[i].b[3]);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vx.uw+=vrmpy (Vu.ub, Vv.ub)
```

```
HVX_Vector Q6_Vuw_vrmpyacc_VuVubVub (HVX_Vector
Vx, HVX_Vector Vu, HVX_Vector Vv)
```

```
Vx.w+=vrmpy (Vu.b, Vv.b)
```

```
HVX_Vector Q6_Vw_vrmpyacc_VwVbVb (HVX_Vector Vx,
HVX_Vector Vu, HVX_Vector Vv)
```

```
Vx.w+=vrmpy (Vu.ub, Vv.b)
```

```
HVX_Vector Q6_Vw_vrmpyacc_VwVubVb (HVX_Vector Vx,
HVX_Vector Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vx.uw+=vrmpy(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vx.w+=vrmpy(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	Vx.w+=vrmpy(Vu.ub,Vv.b)

Field name

ICLASS

Description

Instruction class

Parse

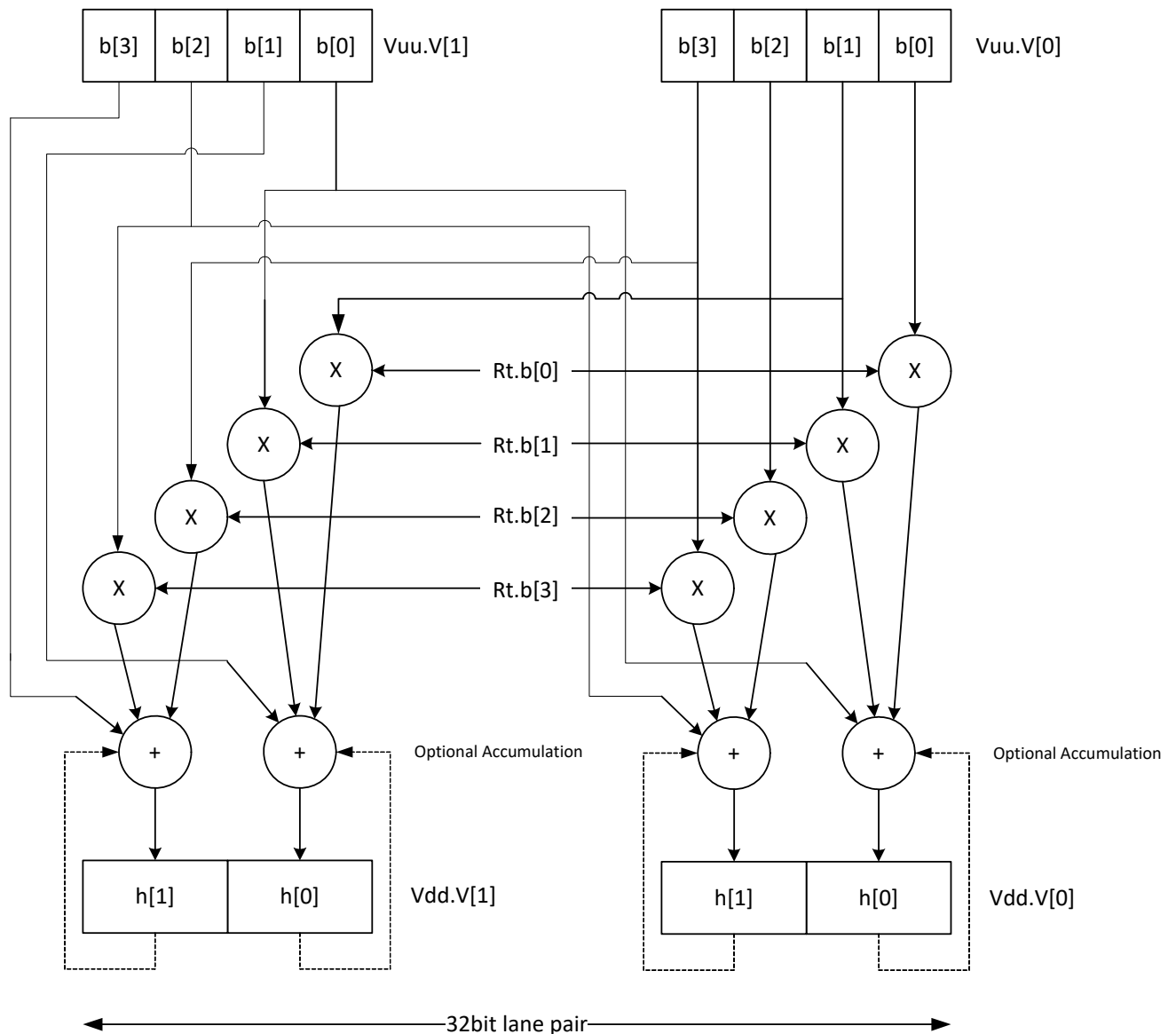
Packet/loop parse bits

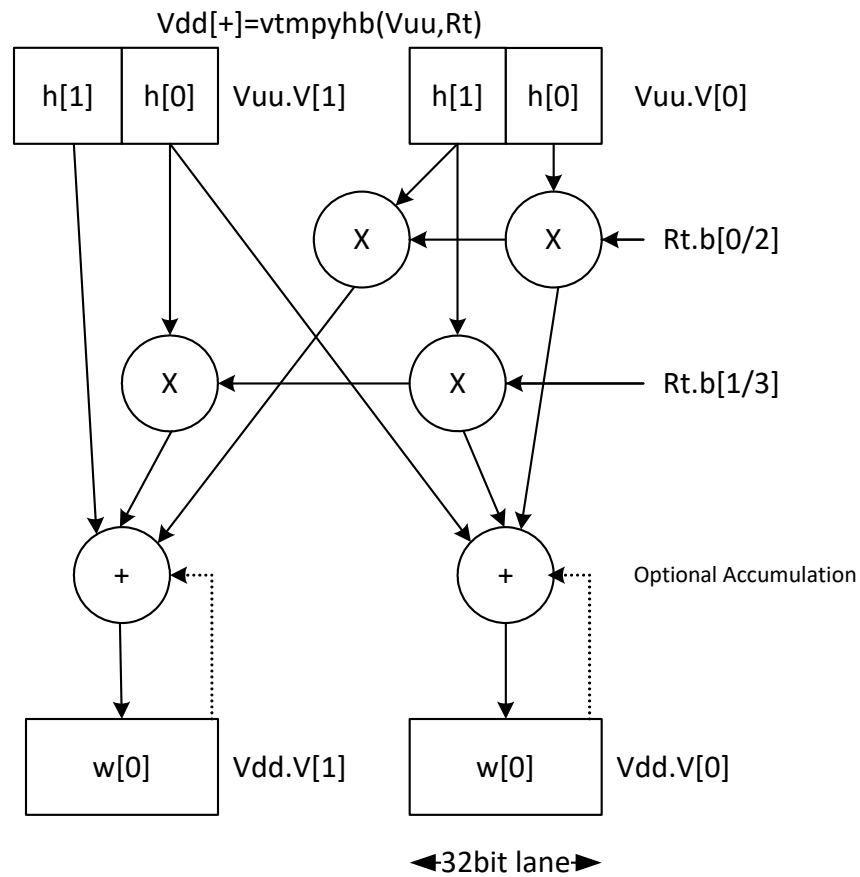
Field name	Description
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Multiply with 3-wide reduction

Perform a 3-element sliding window pattern operation consisting of a two multiplies with an additional accumulation. Data elements are stored in the vector register pair Vuu , and coefficients in the scalar register Rt .

$Vdd.h[+] = vtmpy(Vuu.b, Rt.b)$



**Syntax**

```
Vdd.h=vtncpy(Vuu.b, Rt.b)
```

```
Vdd.h=vtncpy(Vuu.ub, Rt.b)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = (Vuu.v[0].h[i].b[0] *
    Rt.b[(2*i) % 4]);
    Vdd.v[0].h[i] += (Vuu.v[0].h[i].b[1] *
    Rt.b[(2*i+1) % 4]);
    Vdd.v[0].h[i] += Vuu.v[1].h[i].b[0];
    Vdd.v[1].h[i] = (Vuu.v[0].h[i].b[1] *
    Rt.b[(2*i) % 4]);
    Vdd.v[1].h[i] += (Vuu.v[1].h[i].b[0] *
    Rt.b[(2*i+1) % 4]);
    Vdd.v[1].h[i] += Vuu.v[1].h[i].b[1];
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.v[0].h[i] = (Vuu.v[0].uh[i].ub[0] *
    Rt.b[(2*i) % 4]);
    Vdd.v[0].h[i] += (Vuu.v[0].uh[i].ub[1] *
    Rt.b[(2*i+1) % 4]);
    Vdd.v[0].h[i] += Vuu.v[1].uh[i].ub[0];
    Vdd.v[1].h[i] = (Vuu.v[0].uh[i].ub[1] *
    Rt.b[(2*i) % 4]);
    Vdd.v[1].h[i] += (Vuu.v[1].uh[i].ub[0] *
    Rt.b[(2*i+1) % 4]);
    Vdd.v[1].h[i] += Vuu.v[1].uh[i].ub[1];
}
```

Syntax	Behavior
<code>Vdd.w=vtmpy(Vuu.h,Rt.b)</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vdd.v[0].w[i] = (Vuu.v[0].w[i].h[0] * Rt.b[(2*i+0)%4]); Vdd.v[0].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+1)%4]); Vdd.v[0].w[i] += Vuu.v[1].w[i].h[0]; Vdd.v[1].w[i] = (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+0)%4]); Vdd.v[1].w[i] += (Vuu.v[1].w[i].h[0] * Rt.b[(2*i+1)%4]); Vdd.v[1].w[i] += Vuu.v[1].w[i].h[1] ; } </pre>
<code>Vxx.h+=vtmpy(Vuu.b,Rt.b)</code>	<pre> for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vuu.v[0].h[i].b[0] * Rt.b[(2*i)%4]); Vxx.v[0].h[i] += (Vuu.v[0].h[i].b[1] * Rt.b[(2*i+1)%4]); Vxx.v[0].h[i] += Vuu.v[1].h[i].b[0]; Vxx.v[1].h[i] += (Vuu.v[0].h[i].b[1] * Rt.b[(2*i)%4]); Vxx.v[1].h[i] += (Vuu.v[1].h[i].b[0] * Rt.b[(2*i+1)%4]); Vxx.v[1].h[i] += Vuu.v[1].h[i].b[1] ; } </pre>
<code>Vxx.h+=vtmpy(Vuu.ub,Rt.b)</code>	<pre> for (i = 0; i < VELEM(16); i++) { Vxx.v[0].h[i] += (Vuu.v[0].uh[i].ub[0] * Rt.b[(2*i)%4]); Vxx.v[0].h[i] += (Vuu.v[0].uh[i].ub[1] * Rt.b[(2*i+1)%4]); Vxx.v[0].h[i] += Vuu.v[1].uh[i].ub[0]; Vxx.v[1].h[i] += (Vuu.v[0].uh[i].ub[1] * Rt.b[(2*i)%4]); Vxx.v[1].h[i] += (Vuu.v[1].uh[i].ub[0] * Rt.b[(2*i+1)%4]); Vxx.v[1].h[i] += Vuu.v[1].uh[i].ub[1] ; } </pre>
<code>Vxx.w+=vtmpy(Vuu.h,Rt.b)</code>	<pre> for (i = 0; i < VELEM(32); i++) { Vxx.v[0].w[i] += (Vuu.v[0].w[i].h[0] * Rt.b[(2*i+0)%4]); Vxx.v[0].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+1)%4]); Vxx.v[0].w[i] += Vuu.v[1].w[i].h[0]; Vxx.v[1].w[i] += (Vuu.v[0].w[i].h[1] * Rt.b[(2*i+0)%4]); Vxx.v[1].w[i] += (Vuu.v[1].w[i].h[0] * Rt.b[(2*i+1)%4]); Vxx.v[1].w[i] += Vuu.v[1].w[i].h[1] ; } </pre>

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

Vdd.h=vtmpy(Vuu.b,Rt.b)	HVX_VectorPair Q6_Wh_vtmpy_WbRb (HVX_VectorPair Vuu, Word32 Rt)
Vdd.h=vtmpy(Vuu.ub,Rt.b)	HVX_VectorPair Q6_Wh_vtmpy_WubRb (HVX_VectorPair Vuu, Word32 Rt)
Vdd.w=vtmpy(Vuu.h,Rt.b)	HVX_VectorPair Q6_Ww_vtmpy_WhRb (HVX_VectorPair Vuu, Word32 Rt)
Vxx.h+=vtmpy(Vuu.b,Rt.b)	HVX_VectorPair Q6_Wh_vtmpyacc_WhWbRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.h+=vtmpy(Vuu.ub,Rt.b)	HVX_VectorPair Q6_Wh_vtmpyacc_WhWubRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)
Vxx.w+=vtmpy(Vuu.h,Rt.b)	HVX_VectorPair Q6_Ww_vtmpyacc_WwWhRb (HVX_VectorPair Vxx, HVX_VectorPair Vuu, Word32 Rt)

Encoding

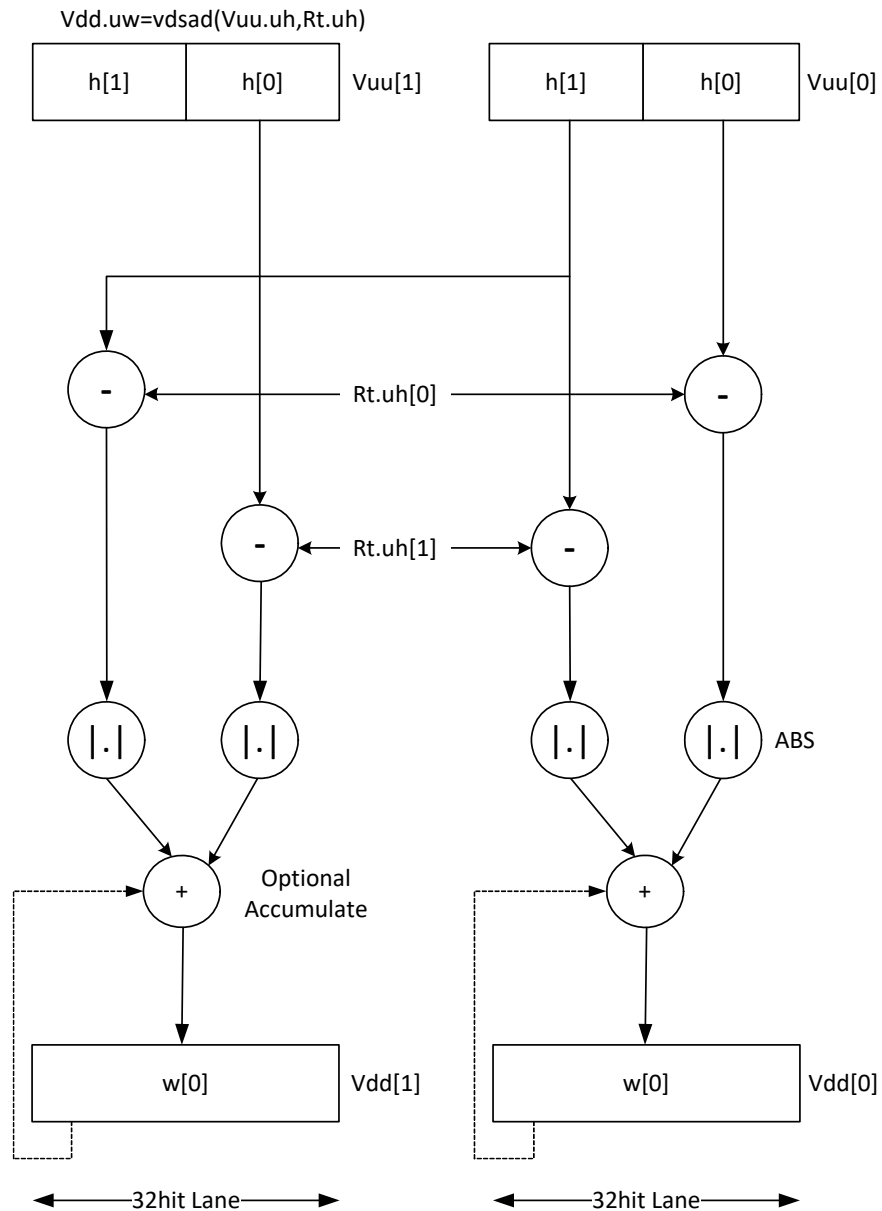
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.h=vtmpy(Vuu.b,Rt.b)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vdd.h=vtmpy(Vuu.ub,Rt.b)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vxx.h+=vtmpy(Vuu.b,Rt.b)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vxx.h+=vtmpy(Vuu.ub,Rt.b)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	Vxx.w+=vtmpy(Vuu.h,Rt.b)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.w=vtmpy(Vuu.h,Rt.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Sum of reduction of absolute differences halfwords

Takes groups of 2 unsigned halfwords from the vector register source V_{uu} , subtracts the halfwords from the scalar register R_t , and takes the absolute value as an unsigned result. These are summed together and optionally added to the destination register V_{xx} , or written directly to V_{dd} . The even destination register contains the data from $V_{uu}[0]$ and R_t , $V_{dd}[1]$ contains the absolute difference of half of the data from $V_{uu}[0]$ and half from $V_{uu}[1]$.

This operation is used to implement a sliding window.



Syntax

```
Vdd.uw=vdsad(Vuu.uh,Rt.uh)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vdd.v[0].uw[i] = ABS(Vuu.v[0].uw[i].uh[0] -
    Rt.uh[0]);
    Vdd.v[0].uw[i] += ABS(Vuu.v[0].uw[i].uh[1] -
    Rt.uh[1]);
    Vdd.v[1].uw[i] = ABS(Vuu.v[0].uw[i].uh[1] -
    Rt.uh[0]);
    Vdd.v[1].uw[i] += ABS(Vuu.v[1].uw[i].uh[0] -
    Rt.uh[1]);
}
```

```
Vxx.uw+=vdsad(Vuu.uh,Rt.uh)
```

```
for (i = 0; i < VELEM(32); i++) {
    Vxx.v[0].uw[i] += ABS(Vuu.v[0].uw[i].uh[0] -
    Rt.uh[0]);
    Vxx.v[0].uw[i] += ABS(Vuu.v[0].uw[i].uh[1] -
    Rt.uh[1]);
    Vxx.v[1].uw[i] += ABS(Vuu.v[0].uw[i].uh[1] -
    Rt.uh[0]);
    Vxx.v[1].uw[i] += ABS(Vuu.v[1].uw[i].uh[0] -
    Rt.uh[1]);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses both HVX multiply resources.

Intrinsics

```
Vdd.uw=vdsad(Vuu.uh,Rt.uh)
```

```
HVX_VectorPair
Q6_Wuw_vdsad_WuhRuh(HVX_VectorPair Vuu, Word32
Rt)
```

```
Vxx.uw+=vdsad(Vuu.uh,Rt.uh)
```

```
HVX_VectorPair
Q6_Wuw_vdsadacc_WuwWuhRuh(HVX_VectorPair Vxx,
HVX_VectorPair Vuu, Word32 Rt)
```

Encoding

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	
ICLASS												t5				Parse		u5					d5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vdd.uw=vdsad(Vuu.uh,Rt.uh)
ICLASS												t5				Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vxx.uw+=vdsad(Vuu.uh,Rt.uh)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d

Field name	Description
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

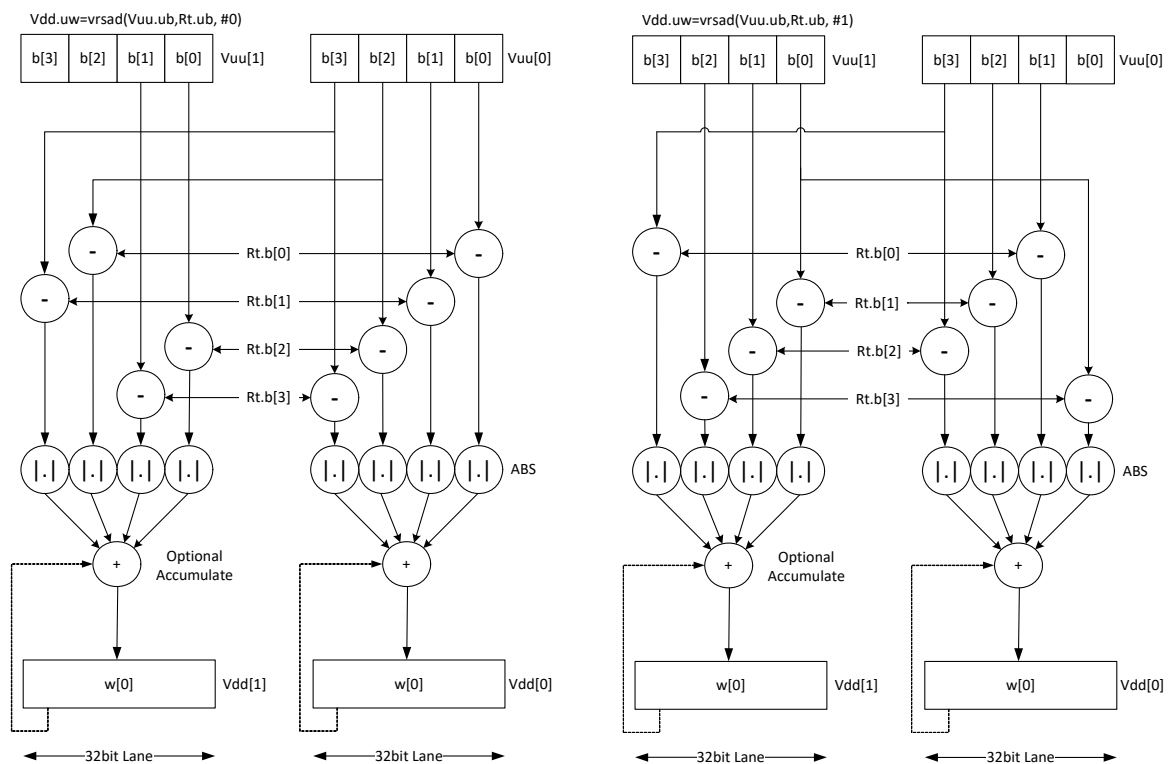
Sum of absolute differences byte

Take groups of four bytes from the vector register source Vuu , subtract the bytes from the scalar register Rt , and take the absolute value as an unsigned result. These are summed together and optionally added to the destination register Vxx , or written directly to Vdd .

If $\#u1$ is 0, the even destination register contains the data from $Vuu[0]$ and Rt , $Vdd[1]$ contains the absolute difference of half of the data from $Vuu[0]$ and half from $Vuu[1]$.

If $\#u1$ is 1 $Vdd[0]$ takes byte 0 from $Vuu[1]$ and bytes 1,2,3 from $Vuu[0]$, while $Vdd[1]$ takes byte 3 from $Vuu[0]$ and the rest from $Vuu[1]$.

This operation is used to implement a sliding window between data in Vuu and Rt .



Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses both HVX multiply resources.

Syntax

```
Vdd.uw=vrsad(Vuu.ub,Rt.ub,#u1)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vdd.v[0].uw[i] =
    ABS(Vuu.v[#u?1:0].uw[i].ub[0] - Rt.ub[(0-
    #u)&3]);
    Vdd.v[0].uw[i] += ABS(Vuu.v[0].uw[i].ub[1]
    - Rt.ub[(1-#u)&3]);
    Vdd.v[0].uw[i] += ABS(Vuu.v[0].uw[i].ub[2]
    - Rt.ub[(2-#u)&3]);
    Vdd.v[0].uw[i] += ABS(Vuu.v[0].uw[i].ub[3]
    - Rt.ub[(3-#u)&3]);
    Vdd.v[1].uw[i] = ABS(Vuu.v[1].uw[i].ub[0] -
    Rt.ub[(2-#u)&3]);
    Vdd.v[1].uw[i] += ABS(Vuu.v[1].uw[i].ub[1]
    - Rt.ub[(3-#u)&3]);
    Vdd.v[1].uw[i] +=
    ABS(Vuu.v[#u?1:0].uw[i].ub[2] - Rt.ub[(0-
    #u)&3]);
    Vdd.v[1].uw[i] += ABS(Vuu.v[0].uw[i].ub[3]
    - Rt.ub[(1-#u)&3]);
}
```

```
Vxx.uw+=vrsad(Vuu.ub,Rt.ub,#u1)
```

```
for (i = 0; i < VELEM(32); i++) {
    Vxx.v[0].uw[i] +=
    ABS(Vuu.v[#u?1:0].uw[i].ub[0] - Rt.ub[(0-
    #u)&3]);
    Vxx.v[0].uw[i] += ABS(Vuu.v[0].uw[i].ub[1]
    - Rt.ub[(1-#u)&3]);
    Vxx.v[0].uw[i] += ABS(Vuu.v[0].uw[i].ub[2]
    - Rt.ub[(2-#u)&3]);
    Vxx.v[0].uw[i] += ABS(Vuu.v[0].uw[i].ub[3]
    - Rt.ub[(3-#u)&3]);
    Vxx.v[1].uw[i] += ABS(Vuu.v[1].uw[i].ub[0]
    - Rt.ub[(2-#u)&3]);
    Vxx.v[1].uw[i] += ABS(Vuu.v[1].uw[i].ub[1]
    - Rt.ub[(3-#u)&3]);
    Vxx.v[1].uw[i] +=
    ABS(Vuu.v[#u?1:0].uw[i].ub[2] - Rt.ub[(0-
    #u)&3]);
    Vxx.v[1].uw[i] += ABS(Vuu.v[0].uw[i].ub[3]
    - Rt.ub[(1-#u)&3]);
}
```

Intrinsics

```
Vdd.uw=vrsad(Vuu.ub,Rt.ub,#u1)
```

```
HVX_VectorPair
Q6_Wuw_vrsad_WubRubI(HVX_VectorPair Vuu, Word32
Rt, Word32 Iu1)
```

```
Vxx.uw+=vrsad(Vuu.ub,Rt.ub,#u1)
```

```
HVX_VectorPair
Q6_Wuw_vrsadacc_WuwWubRubI(HVX_VectorPair Vxx,
HVX_VectorPair Vuu, Word32 Rt, Word32 Iu1)
```

Encoding

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	
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	i	d	d	d	d	d	Vdd.uw=vrsad(Vuu.ub,Rt.ub,#u1)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	i	x	x	x	x	x	Vxx.uw+=vrsad(Vuu.ub,Rt.ub,#u1)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

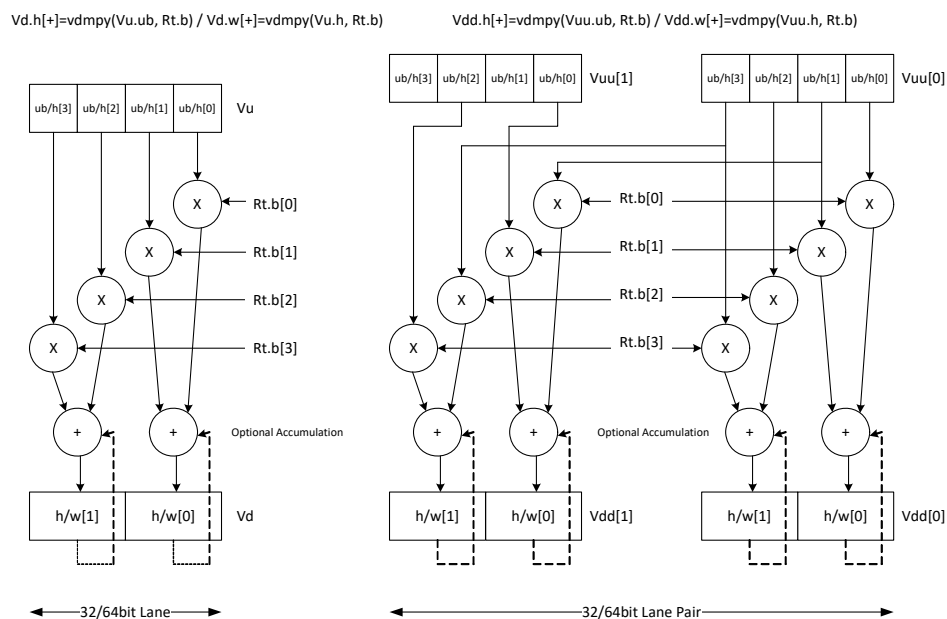
6.9 HVX/MPY-RESOURCE

The HVX/MPY-RESOURCE instruction subclass includes instructions that use a single HVX multiply resource.

Multiply by byte with 2-wide reduction

Multiply elements from Vu by the corresponding elements in the scalar register Rt. The products are added in pairs to yield a by-2 reduction. The products can optionally be accumulated with Vx.

Supports multiplication of unsigned bytes by bytes, and halfwords by signed bytes. The double-vector version performs a sliding-window 2-way reduction, where the odd register output contains the offset computation.



Syntax

$Vd.h=vdmpy(Vu.ub, Rt.b)$

$Vd.w=vdmpy(Vu.h, Rt.b)$

$Vx.h+=vdmpy(Vu.ub, Rt.b)$

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = (Vu.ub[i].ub[0] * Rt.b[(2*i) % 4]);
    Vd.h[i] += (Vu.ub[i].ub[1] * Rt.b[(2*i+1) % 4]);
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.h[i].h[0] * Rt.b[(2*i+0) % 4]);
    Vd.w[i] += (Vu.h[i].h[1] * Rt.b[(2*i+1) % 4]);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vx.h[i] += (Vu.ub[i].ub[0] * Rt.b[(2*i) % 4]);
    Vx.h[i] += (Vu.ub[i].ub[1] * Rt.b[(2*i+1) % 4]);
}
```

Syntax

```
Vx.w+=vdmpy(Vu.h,Rt.b)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] += (Vu.w[i].h[0] * Rt.b[(2*i+0)%4]);
    Vx.w[i] += (Vu.w[i].h[1] * Rt.b[(2*i+1)%4]);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vd.h=vdmpy(Vu.ub,Rt.b)
```

```
HVX_Vector Q6_Vh_vdmpy_VubRb(HVX_Vector Vu,
Word32 Rt)
```

```
Vd.w=vdmpy(Vu.h,Rt.b)
```

```
HVX_Vector Q6_Vw_vdmpy_VhRb(HVX_Vector Vu,
Word32 Rt)
```

```
Vx.h+=vdmpy(Vu.ub,Rt.b)
```

```
HVX_Vector Q6_Vh_vdmpyacc_VhVubRb(HVX_Vector Vx,
HVX_Vector Vu, Word32 Rt)
```

```
Vx.w+=vdmpy(Vu.h,Rt.b)
```

```
HVX_Vector Q6_Vw_vdmpyacc_VwVhRb(HVX_Vector Vx,
HVX_Vector Vu, Word32 Rt)
```

Encoding

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	
ICLASS												t5				Parse		u5					d5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.w=vdmpy(Vu.h,Rt.b)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.h=vdmpy(Vu.ub,Rt.b)
ICLASS												t5				Parse		u5					x5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	Vx.w+=vdmpy(Vu.h,Rt.b)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	0	x	x	x	x	x	Vx.h+=vdmpy(Vu.ub,Rt.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Multiply half of the elements (16x16)

Multiply even elements of Vu by odd elements of Vv, shift the result left by 16 bits, and place the result in each lane of Vd. This instruction is useful for 32x32 low-half multiplies.

Syntax

```
Vd.w=vmpyieo(Vu.h,Vv.h)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.w[i].h[0]*Vv.w[i].h[1]) << 16;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vd.w=vmpyieo(Vu.h,Vv.h)
```

```
HVX_Vector Q6_Vw_vmpyieo_VhVh(HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

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	
ICLASS											Parse		u5					d5														
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vmpyieo(Vu.h,Vv.h)

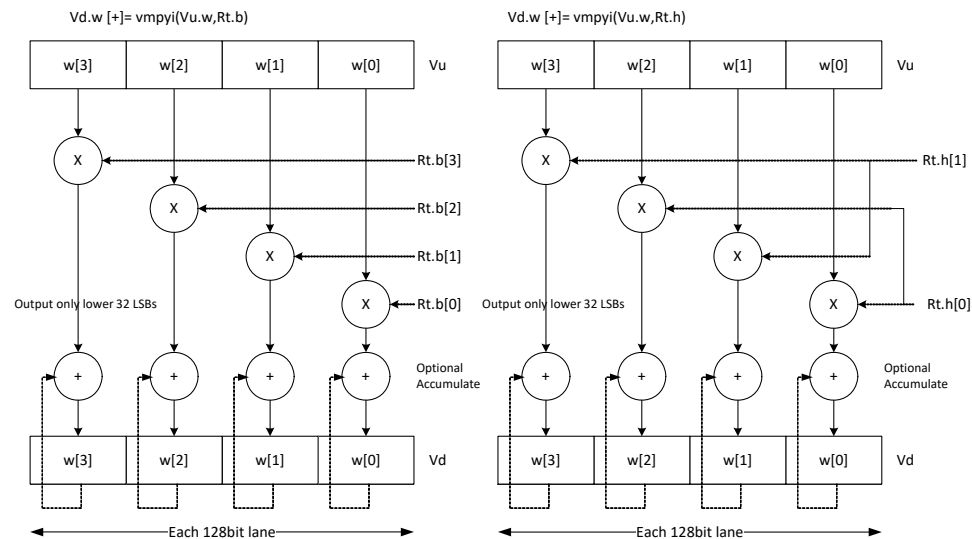
Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Integer multiply by byte

Multiply groups of words in vector register Vu by the elements in Rt . The lower 32-bit results are placed in vector register Vd .

The operation has one form: signed words in Vu multiplied by signed bytes in Rt .

Optionally accumulates the product with the destination vector register Vx .



Syntax

$Vd.h = vmpyi(Vu.h, Rt.b)$

$Vd.w = vmpyi(Vu.w, Rt.b)$

$Vd.w = vmpyi(Vu.w, Rt.ub)$

$Vx.h += vmpyi(Vu.h, Rt.b)$

$Vx.w += vmpyi(Vu.w, Rt.b)$

$Vx.w += vmpyi(Vu.w, Rt.ub)$

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.h[i] = (Vu.h[i] * Rt.b[i % 4]) ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.w[i] * Rt.b[i % 4]) ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vd.w[i] = (Vu.w[i] * Rt.ub[i % 4]) ;
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vx.h[i] += (Vu.h[i] * Rt.b[i % 4]) ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] += (Vu.w[i] * Rt.b[i % 4]) ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.w[i] += (Vu.w[i] * Rt.ub[i % 4]) ;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

Vd.h=vmpyi (Vu.h,Rt.b)	HVX_Vector Q6_Vh_vmpyi_VhRb (HVX_Vector Vu, Word32 Rt)
Vd.w=vmpyi (Vu.w,Rt.b)	HVX_Vector Q6_Vw_vmpyi_VwRb (HVX_Vector Vu, Word32 Rt)
Vd.w=vmpyi (Vu.w,Rt.ub)	HVX_Vector Q6_Vw_vmpyi_VwRub (HVX_Vector Vu, Word32 Rt)
Vx.h+=vmpyi (Vu.h,Rt.b)	HVX_Vector Q6_Vh_vmpyiacc_VhVhRb (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
Vx.w+=vmpyi (Vu.w,Rt.b)	HVX_Vector Q6_Vw_vmpyiacc_VwVwRb (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
Vx.w+=vmpyi (Vu.w,Rt.ub)	HVX_Vector Q6_Vw_vmpyiacc_VwVwRub (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)

Encoding

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	
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	Vx.w+=vmpyi(Vu.w,Rt.b)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.h=vmpyi(Vu.h,Rt.b)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vx.h+=vmpyi(Vu.h,Rt.b)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.w=vmpyi(Vu.w,Rt.ub)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vx.w+=vmpyi(Vu.w,Rt.ub)
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vmpyi(Vu.w,Rt.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Multiply half of the elements with scalar (16 x 16)

Unsigned 16 x 16 multiply of the lower halfword of each word in the vector with the lower halfword of the 32-bit scalar.

Syntax

```
Vd.uw=vmpye (Vu.uh, Rt.uh)
```

```
Vx.uw+=vmpye (Vu.uh, Rt.uh)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.uw[i] = (Vu.uw[i].uh[0] * Rt.uh[0]) ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vx.uw[i] += (Vu.uw[i].uh[0] * Rt.uh[0]) ;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vd.uw=vmpye (Vu.uh, Rt.uh)
```

```
HVX_Vector Q6_Vuw_vmpye_VuhRuh (HVX_Vector Vu,
Word32 Rt)
```

```
Vx.uw+=vmpye (Vu.uh, Rt.uh)
```

```
HVX_Vector Q6_Vuw_vmpyeacc_VuwVuhRuh (HVX_Vector
Vx, HVX_Vector Vu, Word32 Rt)
```

Encoding

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	
ICLASS											t5					Parse		u5					d5									
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uw=vmpye(Vu.uh,Rt.uh)
ICLASS											t5					Parse		u5					x5									
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	1	x	x	x	x	x	Vx.uw+=vmpye(Vu.uh,Rt.uh)

Field name

Description

ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Multiply bytes with 4-wide reduction - vector by scalar

Perform multiplication between the elements in vector Vu and the corresponding elements in the scalar register Rt, followed by a 4-way reduction to a word in each 32-bit lane.

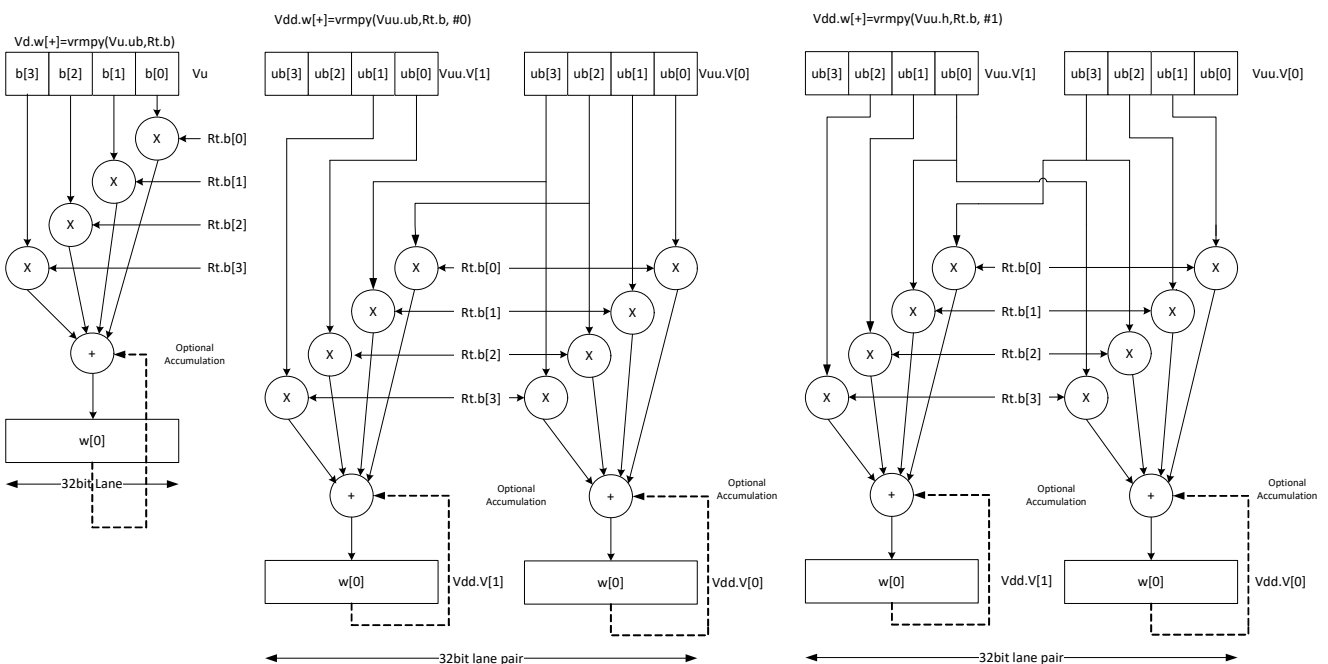
Supports the multiplication of unsigned byte data by signed or unsigned bytes in the scalar.

The operation has two forms:

- The first performs simple dot product of four elements into a single result
- The second form takes a one bit immediate input and generates a vector register pair

For #1 = 0 the even destination contains a simple dot product, the odd destination contains a dot product of the coefficients rotated by two elements and the upper two data elements taken from the even register of Vuu.

For #u = 1, the even destination takes coefficients rotated by -1 and data element 0 from the odd register of Vuu. The odd destination uses coefficients rotated by -1 and takes data element 3 from the even register of Vuu.



Syntax

```
Vd.uw=vrmpy(Vu.ub,Rt.ub)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
  Vd.uw[i] = (Vu.uw[i].ub[0] * Rt.ub[0]);
  Vd.uw[i] += (Vu.uw[i].ub[1] * Rt.ub[1]);
  Vd.uw[i] += (Vu.uw[i].ub[2] * Rt.ub[2]);
  Vd.uw[i] += (Vu.uw[i].ub[3] * Rt.ub[3]);
}
```

Syntax

```
Vd.w=vrmpy(Vu.ub,Rt.b)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
  Vd.w[i] = (Vu.uw[i].ub[0] * Rt.b[0]);
  Vd.w[i] += (Vu.uw[i].ub[1] * Rt.b[1]);
  Vd.w[i] += (Vu.uw[i].ub[2] * Rt.b[2]);
  Vd.w[i] += (Vu.uw[i].ub[3] * Rt.b[3]);
}
```

```
Vx.uw+=vrmpy(Vu.ub,Rt.ub)
```

```
for (i = 0; i < VELEM(32); i++) {
  Vx.uw[i] += (Vu.uw[i].ub[0] * Rt.ub[0]);
  Vx.uw[i] += (Vu.uw[i].ub[1] * Rt.ub[1]);
  Vx.uw[i] += (Vu.uw[i].ub[2] * Rt.ub[2]);
  Vx.uw[i] += (Vu.uw[i].ub[3] * Rt.ub[3]);
}
```

```
Vx.w+=vrmpy(Vu.ub,Rt.b)
```

```
for (i = 0; i < VELEM(32); i++) {
  Vx.w[i] += (Vu.uw[i].ub[0] * Rt.b[0]);
  Vx.w[i] += (Vu.uw[i].ub[1] * Rt.b[1]);
  Vx.w[i] += (Vu.uw[i].ub[2] * Rt.b[2]);
  Vx.w[i] += (Vu.uw[i].ub[3] * Rt.b[3]);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vd.uw=vrmpy(Vu.ub,Rt.ub)
```

```
HVX_Vector Q6_Vuw_vrmpy_VubRub(HVX_Vector Vu,
Word32 Rt)
```

```
Vd.w=vrmpy(Vu.ub,Rt.b)
```

```
HVX_Vector Q6_Vw_vrmpy_VubRb(HVX_Vector Vu,
Word32 Rt)
```

```
Vx.uw+=vrmpy(Vu.ub,Rt.ub)
```

```
HVX_Vector Q6_Vuw_vrmpyacc_VuwVubRub(HVX_Vector
Vx, HVX_Vector Vu, Word32 Rt)
```

```
Vx.w+=vrmpy(Vu.ub,Rt.b)
```

```
HVX_Vector Q6_Vw_vrmpyacc_VwVubRb(HVX_Vector Vx,
HVX_Vector Vu, Word32 Rt)
```

Encoding

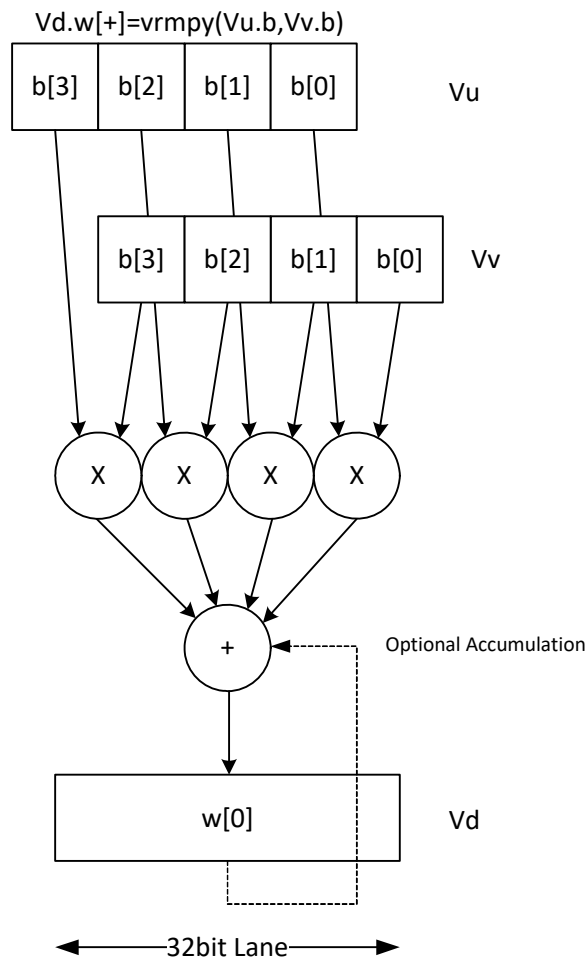
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS												t5				Parse		u5					d5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.uw=vrmpy(Vu.ub,Rt.ub)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.w=vrmpy(Vu.ub,Rt.b)
ICLASS												t5				Parse		u5					x5									
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	0	x	x	x	x	x	Vx.uw+=vrmpy(Vu.ub,Rt.ub)
0	0	0	1	1	0	0	1	0	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vx.w+=vrmpy(Vu.ub,Rt.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Multiply by byte with 4-wide reduction - vector by vector

The `vrmpy` instruction performs a dot product function between 4-byte elements in vector register `Vu`, and 4-byte elements in `Vv`. The sum of the products is written into `Vd` as words within each 32-bit lane.

Data types can be unsigned by unsigned, signed by signed or unsigned by signed.



Syntax

```
Vd.uw=vrmpy(Vu.ub,Vv.ub)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.uw[i] = (Vu.uw[i].ub[0] *
Vv.uw[i].ub[0]);
    Vd.uw[i] += (Vu.uw[i].ub[1] *
Vv.uw[i].ub[1]);
    Vd.uw[i] += (Vu.uw[i].ub[2] *
Vv.uw[i].ub[2]);
    Vd.uw[i] += (Vu.uw[i].ub[3] *
Vv.uw[i].ub[3]);
}
```

Syntax

```
Vd.w=vrmpy(Vu.b,Vv.b)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
  Vd.w[i] = (Vu.w[i].b[0] * Vv.w[i].b[0]);
  Vd.w[i] += (Vu.w[i].b[1] * Vv.w[i].b[1]);
  Vd.w[i] += (Vu.w[i].b[2] * Vv.w[i].b[2]);
  Vd.w[i] += (Vu.w[i].b[3] * Vv.w[i].b[3]);
}
```

```
Vd.w=vrmpy(Vu.ub,Vv.b)
```

```
for (i = 0; i < VELEM(32); i++) {
  Vd.w[i] = (Vu.uw[i].ub[0] * Vv.w[i].b[0]);
  Vd.w[i] += (Vu.uw[i].ub[1] * Vv.w[i].b[1]);
  Vd.w[i] += (Vu.uw[i].ub[2] * Vv.w[i].b[2]);
  Vd.w[i] += (Vu.uw[i].ub[3] * Vv.w[i].b[3]);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vd.uw=vrmpy(Vu.ub,Vv.ub)
```

```
HVX_Vector Q6_Vuw_vrmpy_VubVub(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.w=vrmpy(Vu.b,Vv.b)
```

```
HVX_Vector Q6_Vw_vrmpy_VbVb(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.w=vrmpy(Vu.ub,Vv.b)
```

```
HVX_Vector Q6_Vw_vrmpy_VubVb(HVX_Vector Vu,
HVX_Vector Vv)
```

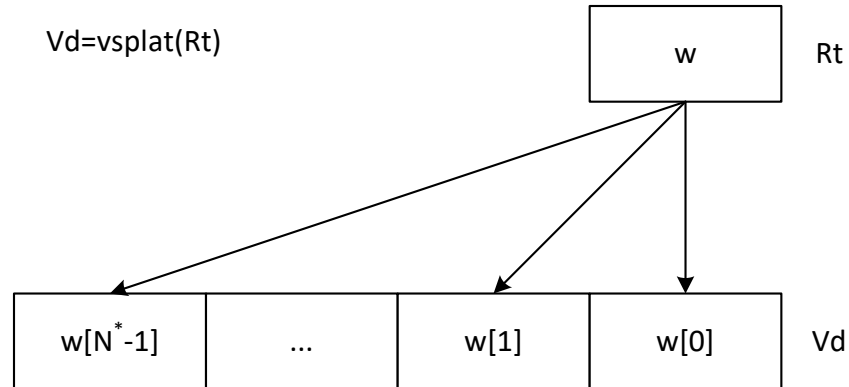
Encoding

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		
ICLASS																Parse		u5					d5										
0	0	0	1	1	1	0	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.uw=vrmpy(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.w=vrmpy(Vu.b,Vv.b)
0	0	0	1	1	1	0	0	0	0	0	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.w=vrmpy(Vu.ub,Vv.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Splat from scalar

Set all destination vector register words to the value specified by the contents of scalar register Rt.



*N number of operations in vector

Syntax

`Vd.b=vsplat(Rt)`

`Vd.h=vsplat(Rt)`

`Vd=vsplat(Rt)`

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vd.ub[i] = Rt ;
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.uh[i] = Rt ;
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vd.uw[i] = Rt ;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

`Vd.b=vsplat(Rt)`

`HVX_Vector Q6_Vb_vsplat_R(Word32 Rt)`

`Vd.h=vsplat(Rt)`

`HVX_Vector Q6_Vh_vsplat_R(Word32 Rt)`

`Vd=vsplat(Rt)`

`HVX_Vector Q6_V_vsplat_R(Word32 Rt)`

Encoding

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	
ICLASS												t5					Parse				d5											
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	-	-	-	-	0	0	0	1	d	d	d	d	d	Vd=vsplat(Rt)
0	0	0	1	1	0	0	1	1	1	0	t	t	t	t	t	P	P	0	-	-	-	-	0	0	1	d	d	d	d	d	Vd.h=vsplat(Rt)	
0	0	0	1	1	0	0	1	1	1	0	t	t	t	t	t	P	P	0	-	-	-	-	0	1	0	d	d	d	d	d	Vd.b=vsplat(Rt)	

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t

Vector to predicate transfer

Copy bits into the destination vector predicate register, under the control of the scalar register Rt and the input vector register Vu. Instead of a direct write, the destination can also be OR'd with the result. If the corresponding byte i of Vu matches any of the bits in Rt byte[i%4] the destination Qd is OR'd with or set to 1 or 0.

If Rt contains 0x01010101, Qt can be filled with the LSBs of Vu, one bit per byte.

Syntax

```
Qd4=vand(Vu,Rt)
```

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    QdV[i]=((Vu.ub[i] & Rt.ub[i % 4]) != 0) ? 1 : 0 ;
}
```

```
Qx4|=vand(Vu,Rt)
```

```
for (i = 0; i < VELEM(8); i++) {
    QxV[i]=QxV[i] | ((Vu.ub[i] & Rt.ub[i % 4]) != 0) ?
    1 : 0) ;
}
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

```
Qd4=vand(Vu,Rt)
```

```
HVX_VectorPred Q6_Q_vand_VR(HVX_Vector Vu,
Word32 Rt)
```

```
Qx4|=vand(Vu,Rt)
```

```
HVX_VectorPred Q6_Q_vandor_QVR(HVX_VectorPred
Qx, HVX_Vector Vu, Word32 Rt)
```

Encoding

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	
ICLASS												t5				Parse		u5								x2						
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	0	-	-	-	x	x	Qx4 =vand(Vu,Rt)
ICLASS												t5				Parse		u5								d2						
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	0	-	1	0	d	d	Qd4=vand(Vu,Rt)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d2	Field to encode register d
t5	Field to encode register t
u5	Field to encode register u
x2	Field to encode register x

Predicate to vector transfer

Copy the byte elements of scalar register Rt into the destination vector register Vd, under the control of the vector predicate register. Instead of a direct write, the destination can be OR'd with the result. If the corresponding bit i of Qu is set, the contents of byte[i % 4] are written or OR'd into Vd or Vx.

If Rt contains 0x01010101, Qt can expand into Vd or Vx, 1 bit per byte.

Syntax	Behavior
Vd=vand(!Qu4,Rt)	for (i = 0; i < VELEM(8); i++) { Vd.ub[i] = (!QuV[i] ? Rt.ub[i % 4] : 0 ; }
Vx =vand(!Qu4,Rt)	for (i = 0; i < VELEM(8); i++) { Vx.ub[i] = (!QuV[i] ? Rt.ub[i % 4] : 0 ; }

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

Vd=vand(!Qu4,Rt)	HVX_Vector Q6_V_vand_QnR(HVX_VectorPred Qu, Word32 Rt)
Vd=vand(Qu4,Rt)	HVX_Vector Q6_V_vand_QR(HVX_VectorPred Qu, Word32 Rt)
Vx =vand(!Qu4,Rt)	HVX_Vector Q6_V_vandor_VQnR(HVX_Vector Vx, HVX_VectorPred Qu, Word32 Rt)
Vx =vand(Qu4,Rt)	HVX_Vector Q6_V_vandor_VQR(HVX_Vector Vx, HVX_VectorPred Qu, Word32 Rt)

Encoding

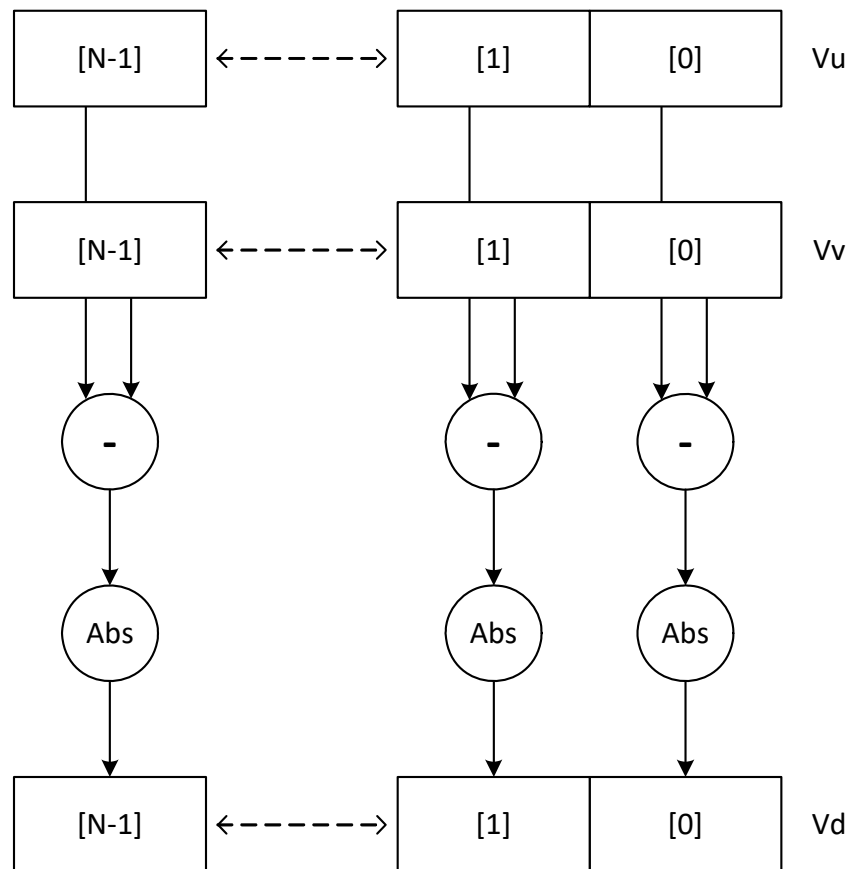
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS												t5				Parse		u2				x5										
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	-	-	0	u	u	0	1	1	x	x	x	x	x	Vx =vand(Qu4,Rt)
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	-	-	1	u	u	0	1	1	x	x	x	x	x	Vx =vand(!Qu4,Rt)
ICLASS												t5				Parse		u2				d5										
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	-	-	0	u	u	1	0	1	d	d	d	d	d	Vd=vand(Qu4,Rt)
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	-	-	1	u	u	1	0	1	d	d	d	d	d	Vd=vand(!Qu4,Rt)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t5	Field to encode register t
u2	Field to encode register u
x5	Field to encode register x

Absolute value of difference

Return the absolute value of the difference between corresponding elements in vector registers V_u and V_v , and place the result in V_d . Supports unsigned byte, signed and unsigned halfword, and signed word.

$V_d.uh = \text{vabsdiff}(V_u.h, V_v.h)$



N is the number of elements implemented in a vector register.

Syntax

$V_d.ub = \text{vabsdiff}(V_u.ub, V_v.ub)$

$V_d.uh = \text{vabsdiff}(V_u.h, V_v.h)$

$V_d.uh = \text{vabsdiff}(V_u.uh, V_v.uh)$

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vd.ub[i] = (Vu.ub[i] > Vv.ub[i]) ? (Vu.ub[i]
- Vv.ub[i]) : (Vv.ub[i] - Vu.ub[i]);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.uh[i] = (Vu.h[i] > Vv.h[i]) ? (Vu.h[i] -
Vv.h[i]) : (Vv.h[i] - Vu.h[i]);
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.uh[i] = (Vu.uh[i] > Vv.uh[i]) ? (Vu.uh[i]
- Vv.uh[i]) : (Vv.uh[i] - Vu.uh[i]);
}
```

Syntax

```
Vd.uw=vabsdiff(Vu.w,Vv.w)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.uw[i] = (Vu.w[i] > Vv.w[i]) ? (Vu.w[i] -
    Vv.w[i]) : (Vv.w[i] - Vu.w[i]);
}
```

Class: COPROC_VX (slots 2,3)**Notes**

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vd.ub=vabsdiff(Vu.ub,Vv.ub)
```

```
HVX_Vector Q6_Vub_vabsdiff_VubVub(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.uh=vabsdiff(Vu.h,Vv.h)
```

```
HVX_Vector Q6_Vuh_vabsdiff_VhVh(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.uh=vabsdiff(Vu.uh,Vv.uh)
```

```
HVX_Vector Q6_Vuh_vabsdiff_VuhVuh(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.uw=vabsdiff(Vu.w,Vv.w)
```

```
HVX_Vector Q6_Vuw_vabsdiff_VwVw(HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.ub=vabsdiff(Vu.ub,Vv.ub)
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.uh=vabsdiff(Vu.h,Vv.h)
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uh=vabsdiff(Vu.uh,Vv.uh)
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.uw=vabsdiff(Vu.w,Vv.w)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Insert element

Insert a 32-bit element in Rt into the destination vector register Vx, at the word element 0.

Syntax

```
Vx.w=vinsert(Rt)
```

Behavior

```
Vx.uw[0] = Rt;
```

Class: COPROC_VX (slots 2,3)

Notes

- This instruction uses a HVX multiply resource.

Intrinsics

```
Vx.w=vinsert(Rt)
```

```
HVX_Vector Q6_Vw_vinsert_VwR(HVX_Vector Vx,  
Word32 Rt)
```

Encoding

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				
ICLASS												t5					Parse													x5					
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	1	-	-	-	-	-	0	0	1	x	x	x	x	x		Vx.w=vinsert(Rt)		

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
t5	Field to encode register t
x5	Field to encode register x

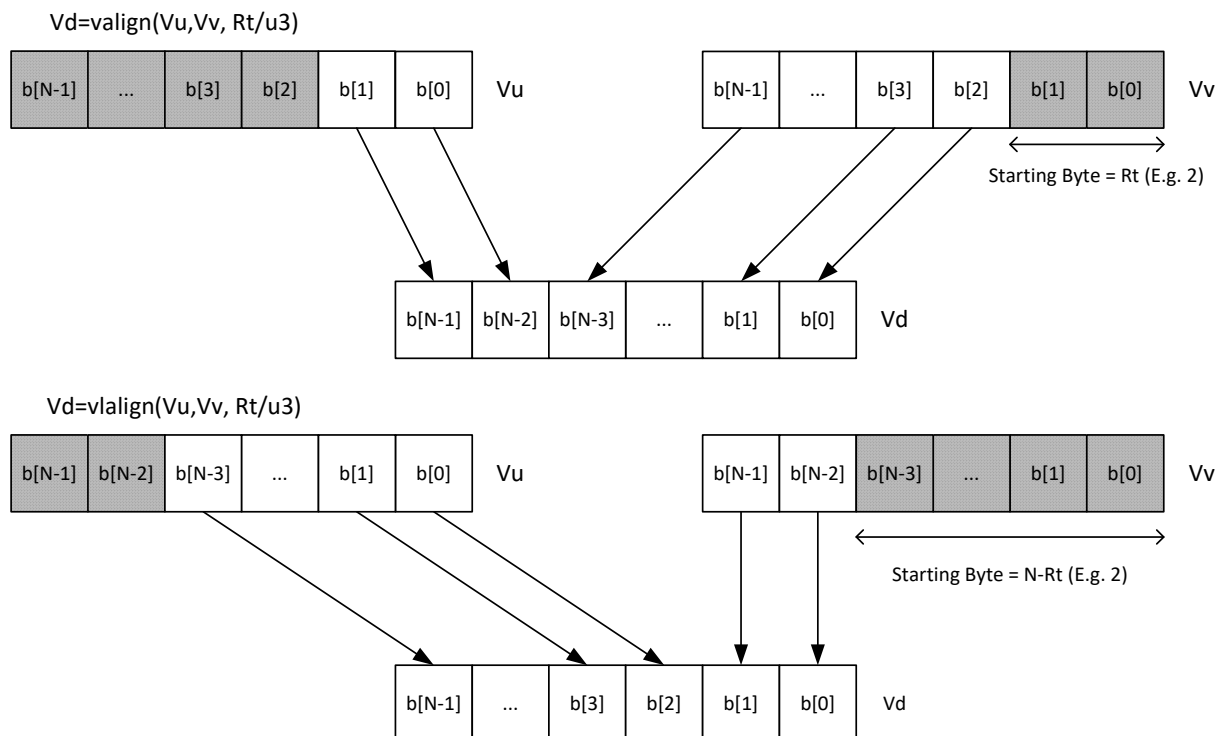
6.10 HVX/PERMUTE-RESOURCE

The HVX/PERMUTE-RESOURCE instruction subclass includes instructions that use the HVX permute resource.

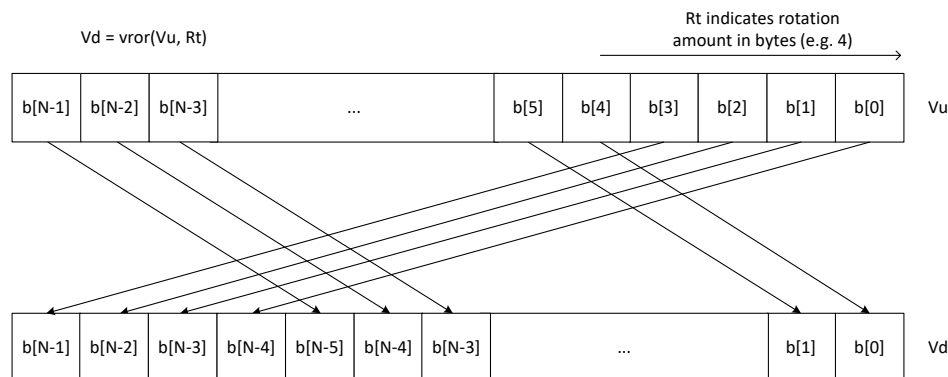
Select a continuous group of bytes the size of a vector register from vector registers V_u and V_v . The starting location is provided by the lower bits of R_t (modulo the vector length) or by a 3-bit immediate value.

There are two forms of the operation. The first, `valign`, uses the R_t or immediate input directly to specify the beginning of the block. The second, `vlalign`, uses the inverse of the input value by subtracting it from the vector length.

The operation can implement a non-aligned vector load, using two aligned loads (above and below the pointer) and a `valign` where the pointer is used as the control input.



Perform a right rotate vector operation on vector register Vu, by the number of bytes specified by the lower bits of Rt. The result is written into Vd. Byte[i] moves to Byte[(i+N-R)%N], where R is the right rotate amount in bytes, and N is the vector register size in bytes.

**Syntax**

Vd=valign(Vu, Vv, #u3)

Vd=valign(Vu, Vv, Rt)

Vd=vlalign(Vu, Vv, #u3)

Vd=vlalign(Vu, Vv, Rt)

Vd=vror(Vu, Rt)

Behavior

```
for(i = 0; i < VWIDTH; i++) {
    Vd.ub[i] = (i+#u>=VWIDTH) ? Vu.ub[i+#u-
VWIDTH] : Vv.ub[i+#u];
}
```

```
unsigned shift = Rt & (VWIDTH-1);
for(i = 0; i < VWIDTH; i++) {
    Vd.ub[i] = (i+shift>=VWIDTH) ?
Vu.ub[i+shift-VWIDTH] : Vv.ub[i+shift];
}
```

```
unsigned shift = VWIDTH - #u;
for(i = 0; i < VWIDTH; i++) {
    Vd.ub[i] = (i+shift>=VWIDTH) ?
Vu.ub[i+shift-VWIDTH] : Vv.ub[i+shift];
}
```

```
unsigned shift = VWIDTH - (Rt & (VWIDTH-1));
for(i = 0; i < VWIDTH; i++) {
    Vd.ub[i] = (i+shift>=VWIDTH) ?
Vu.ub[i+shift-VWIDTH] : Vv.ub[i+shift];
}
```

```
for (k=0;k<VWIDTH;k++) {
    Vd.ub[k] = Vu.ub[(k+Rt)&(VWIDTH-1)];
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX permute resource.
- Input scalar register Rt is limited to registers 0 through 7

Intrinsics

Vd=valign(Vu,Vv,#u3)	HVX_Vector Q6_V_valign_VVI(HVX_Vector Vu, HVX_Vector Vv, Word32 Iu3)
Vd=valign(Vu,Vv,Rt)	HVX_Vector Q6_V_valign_VVR(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd=vlalign(Vu,Vv,#u3)	HVX_Vector Q6_V_vlalign_VVI(HVX_Vector Vu, HVX_Vector Vv, Word32 Iu3)
Vd=vlalign(Vu,Vv,Rt)	HVX_Vector Q6_V_vlalign_VVR(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd=vror(Vu,Rt)	HVX_Vector Q6_V_vror_VR(HVX_Vector Vu, Word32 Rt)

Encoding

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	
ICLASS																t5		Parse		u5					d5							
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd=vror(Vu,Rt)
ICLASS																t3		Parse		u5					d5							
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd=valign(Vu,Vv,Rt)
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd=vlalign(Vu,Vv,Rt)
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	0	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	i	i	i	d	d	d	d	d	Vd=valign(Vu,Vv,#u3)
0	0	0	1	1	1	1	0	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	i	i	i	d	d	d	d	d	Vd=vlalign(Vu,Vv,#u3)

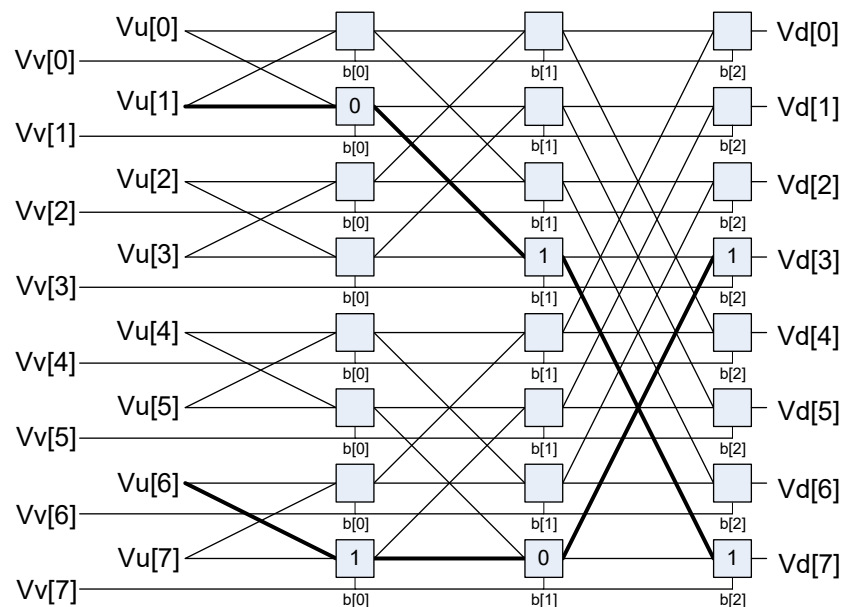
Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t3	Field to encode register t
t5	Field to encode register t
u5	Field to encode register u
v2	Field to encode register v
v3	Field to encode register v
v5	Field to encode register v

General permute network

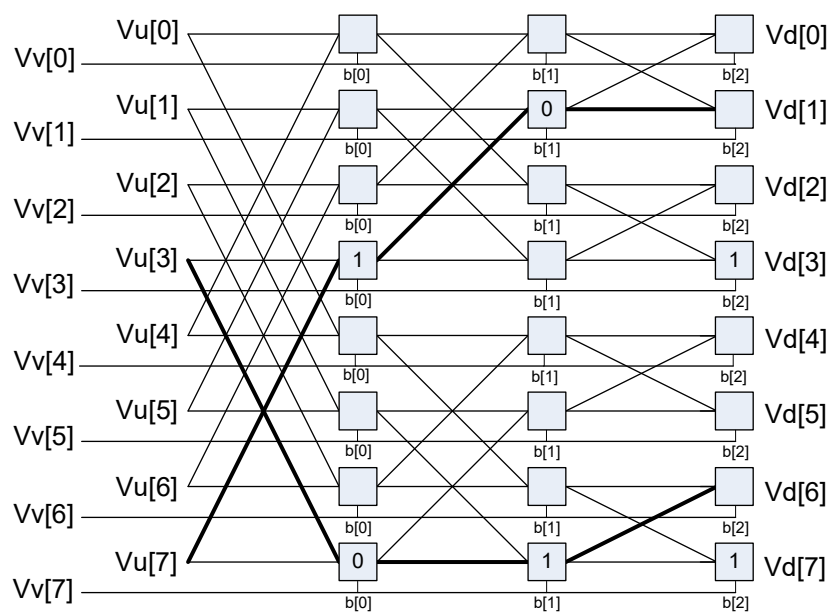
Perform permutation and rearrangement of the 64 input bytes, which is the width of a data slice. The input data is passed through a network of switch boxes, these are able to take two inputs and based on the two controls can pass through, swap, replicate the first input, or replicate the second input. Though the functionality is powerful the algorithms to compute the controls are complex.

The input vector of bytes is passed through six levels of switches that have an increasing stride varying from 1 to 32 at the last stage. The diagram below shows the vrdelta network, the vdelta network is the mirror image, with the largest stride first followed by smaller strides down to 1. Each stage output is controlled by the control inputs in the vector register Vv. For each stage (for example stage 3), the bit at that position looks at the corresponding bit (bit 3) in the control byte. This is shown in the switch box in the diagram.

There are two main forms of data rearrangement. One uses a simple reverse butterfly network shown as vrdelta, and a butterfly network vdelta shown below. These are known as blocking networks, as not all possible paths are allowed, simultaneously from input to output. The data does not have to be a permutation, defined as a one-to-one mapping of every input to its own output position. A subset of data rearrangement such as data replication can be accommodated. It can handle a family of patterns that have symmetric properties.



The diagram below is an example of such a valid pattern using an 8-element vrdelta network for clarity: 0,2,4,6,7,5,3,1.



The desired pattern 0,2,4,6,1,3,5,7 is not possible, as this overuses available paths in the trellis. The position of the output for a particular input is determined by using the bit sequence produced by the destination position D from source position S. The bit vector for the path through the trellis is a function of this destination bit sequence.

In the example $D = 7$, $S = 1$, the element in position 1 is to be moved to position 7. The first switch box control bit at position 1 is 0, the next control bit at position 3 is 1, and finally the bit at position 7 is 1, yielding the sequence 0,1,1. Also, element 6 is moved to position 3, with the control vector 1,0,1. Bits must be placed at the appropriate position in the control bytes to guide the inputs to the desired positions. Every input can be placed into any output, but certain combinations conflict for resources, and so the rearrangement is not possible. A total of 512 control bits are required for a single vrdelta or vdelta slice.

Example of a permitted arrangement:

0,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58,60,62,63,61,59,57,55,53,51,49,47,45,43,41,39,37,35,33,31,29,27,25,23,21,19,17,15,13,11,9,7,5,3,1

Controls =

{0x00,0x02,0x05,0x07,0x0A,0x08,0x0F,0x0D,0x14,0x16,0x11,0x13,0x1E,0x1C,0x1B,0x19,0x28,0x2A,0x2D,0x2F,0x22,0x20,0x27,0x25,0x3C,0x3E,0x39,0x3B,0x36,0x34,0x33,0x31,0x10,0x12,0x15,0x17,0x1A,0x18,0x1F,0x1D,0x04,0x06,0x01,0x03,0x0E,0x0C,0x0B,0x09,0x38,0x3A,0x3D,0x3F,0x32,0x30,0x37,0x35,0x2C,0x2E,0x29,0x2B,0x26,0x24,0x23,0x21}

Similarly, here is a function that replicates every 4th element:

0,0,0,0,4,4,4,4,8,8,8,8,12,12,12,12,16,16,16,16,20,20,20,20,24,24,24,24,28,28,28,28,32,32,32,32,36,36,36,36,40,40,40,40,44,44,44,44,48,48,48,48,52,52,52,52,56,56,56,56,60,60,60,60

Valid controls =

```
{0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x0
3,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x0
3,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x0
3,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x03,0x00,0x01,0x02,0x0
3}
```

The other general form of permute is a Benes network, which requires a vrdelta immediately followed by a vdelta operation. This form is nonblocking: any possible permute, however random, can be accommodated, though it has to be a permutation, each input must have a position in the output. Perform replication by using a pre- or post-conditioning vrdelta pass to perform the replications before or after the permute.

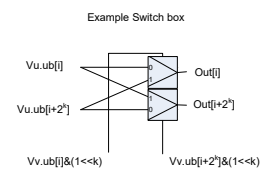
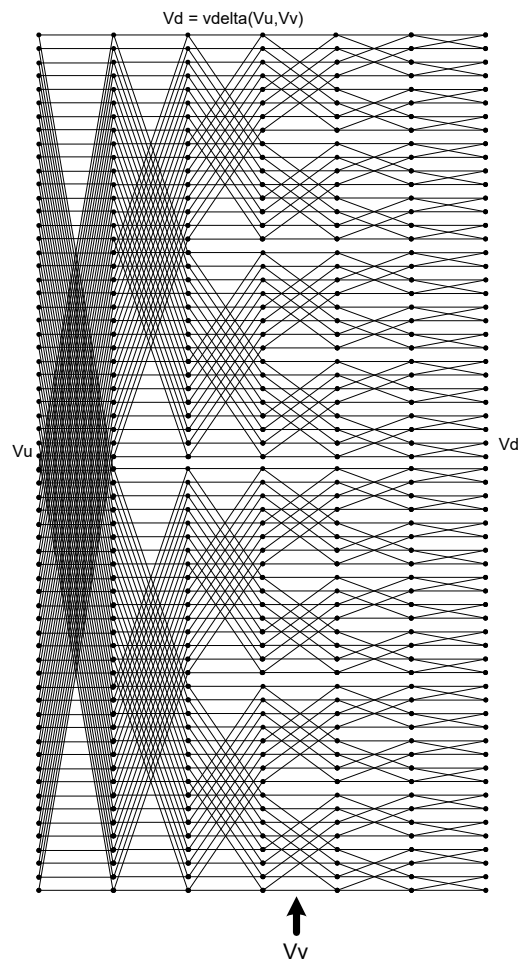
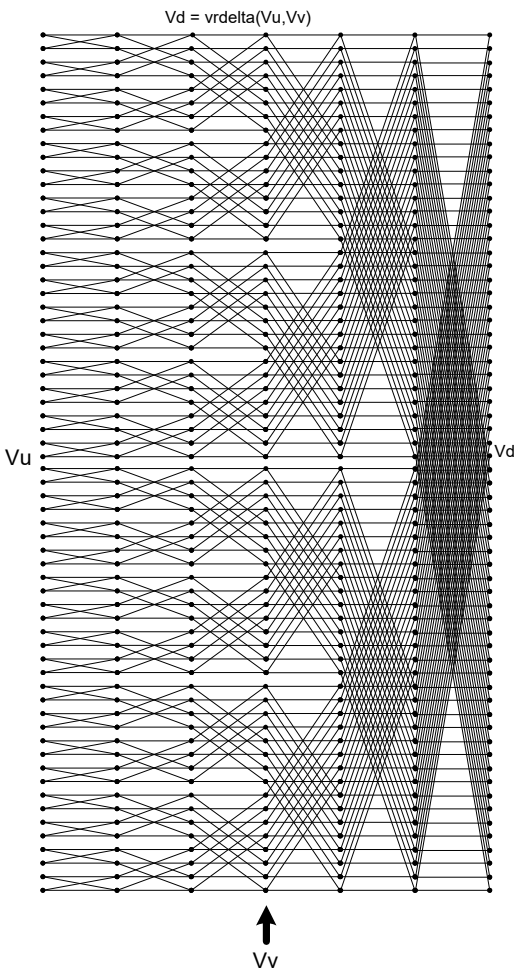
Implement element sizes larger than a byte by grouping bytes together and moving them to a group in the output.

An example of a general permute is the following random mix, where the 64 inputs are put in the following output positions:

```
33,42,40,61,28, 6,17,16,12,38,57,21,58,63,37,13,26,51,50,23,46, 5,52,53, 0,25,39,
7,10,19,18,56,44,41,11,14,43,45, 3,35,32,60,15,55,22,24,48, 9, 4,31,27, 8,
2,62,30,34,54,20,49,59,29,47,36
```

```
vrdelta controls={0x00, 0x00, 0x21, 0x21, 0x20, 0x02, 0x00, 0x02, 0x20, 0x22, 0x00,
0x06, 0x23, 0x23, 0x02, 0x26, 0x06, 0x04, 0x2A, 0x0C, 0x2D, 0x2F, 0x20, 0x2E, 0x04,
0x00, 0x09, 0x29, 0x0C, 0x0A, 0x20, 0x0A, 0x05, 0x0F, 0x29, 0x2B, 0x2C, 0x0E, 0x11,
0x13, 0x31, 0x2F, 0x08, 0x0A, 0x2A, 0x3E, 0x02, 0x32, 0x0B, 0x07, 0x26, 0x0E, 0x2A,
0x2E, 0x36, 0x36, 0x1D, 0x07, 0x01, 0x2B, 0x0C, 0x1E, 0x21, 0x13}
```

```
vdelta controls={ 0x1D, 0x01, 0x00, 0x00, 0x1D, 0x1B, 0x00, 0x1A, 0x1E, 0x02, 0x13,
0x03, 0x0C, 0x18, 0x10, 0x08, 0x1A, 0x06, 0x07, 0x03, 0x11, 0x1D, 0x0D, 0x11, 0x19,
0x03, 0x15, 0x03, 0x03, 0x19, 0x1F, 0x01, 0x1B, 0x1B, 0x06, 0x12, 0x18, 0x00, 0x1D,
0x09, 0x1A, 0x0E, 0x02, 0x02, 0x0B, 0x05, 0x0A, 0x18, 0x1D, 0x1F, 0x01, 0x17, 0x14,
0x06, 0x19, 0x0F, 0x1D, 0x0D, 0x05, 0x01, 0x06, 0x06, 0x0F, 0x1B}
```

**Syntax**

```
Vd=vdelta (Vu, Vv)
```

```
Vd=vrdelta (Vu, Vv)
```

Behavior

```
for (offset=VWIDTH; (offset>>=1)>0; ) {
  for (k = 0; k<VWIDTH; k++) {
    Vd.ub[k] = (Vv.ub[k]&offset) ?
Vu.ub[k^offset] : Vu.ub[k];
  }
  for (k = 0; k<VWIDTH; k++) {
    Vu.ub[k] = Vd.ub[k];
  }
}
```

```
for (offset=1; offset<VWIDTH; offset<<=1){
  for (k = 0; k<VWIDTH; k++) {
    Vd.ub[k] = (Vv.ub[k]&offset) ?
Vu.ub[k^offset] : Vu.ub[k];
  }
  for (k = 0; k<VWIDTH; k++) {
    Vu.ub[k] = Vd.ub[k];
  }
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX permute resource.

Intrinsics

Vd=vdelta(Vu, Vv)

```
HVX_Vector Q6_V_vdelta_VV(HVX_Vector Vu,
HVX_Vector Vv)
```

Vd=vrdelta(Vu, Vv)

```
HVX_Vector Q6_V_vrdelta_VV(HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

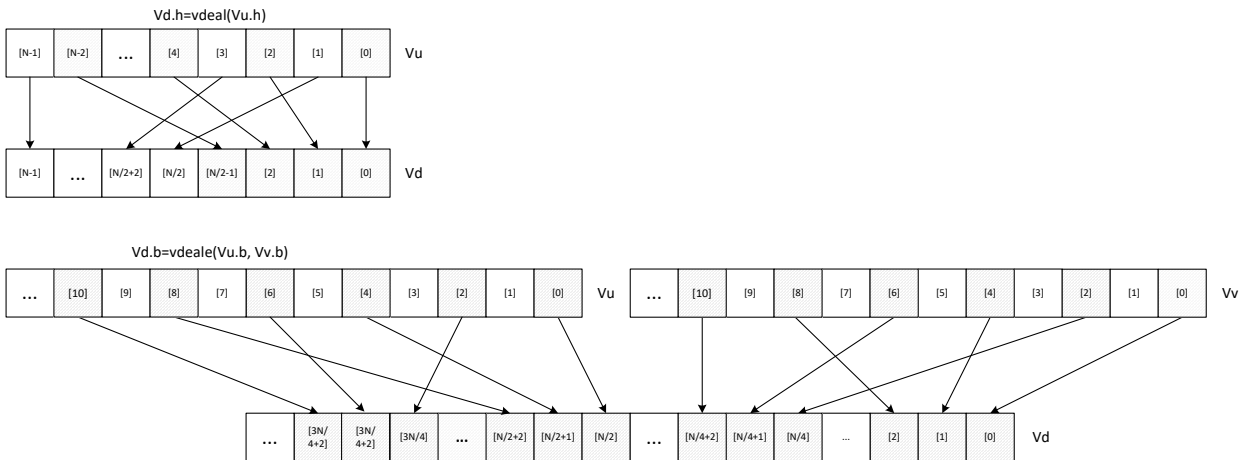
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS											Parse					u5					d5											
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd=vdelta(Vu,Vv)
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd=vrdelta(Vu,Vv)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Shuffle - deal

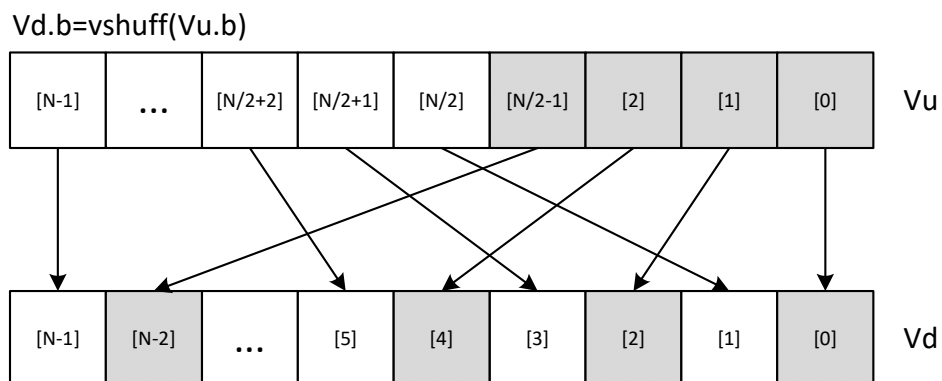
Deal or deinterleave the elements into the destination register Vd. Even elements of Vu are placed in the lower half of Vd, and odd elements are placed in the upper half.

In the case of vdeale, the even elements of Vv are dealt into the lower half of the destination vector register Vd, and the even elements of Vu are dealt into the upper half of Vd. The deal operation takes even-even elements of Vv and places them in the lower quarter of Vd, while odd-even elements of Vv are placed in the second quarter of Vd. Similarly, even-odd elements of Vu are placed in the third quarter of Vd, while odd-odd elements of Vu are placed in the fourth quarter of Vd.



Shuffle elements within a vector. Elements from the same position - but in the upper half of the vector register - are packed together in even and odd element pairs, and then placed in the destination vector register Vd.

Supports byte and halfword. Operates on a single register input, in a way similar to vshuffoe.



*N is the number of element operations allowed in the vector

Syntax	Behavior
<code>Vd.b=vdeal (Vu.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.ub[i] = Vu.uh[i].ub[0]; Vd.ub[i+VBITS/16] = Vu.uh[i].ub[1] ; }</pre>
<code>Vd.b=vdeale (Vu.b,Vv.b)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.ub[0+i] = Vv.uw[i].ub[0]; Vd.ub[VBITS/32+i] = Vv.uw[i].ub[2]; Vd.ub[2*VBITS/32+i] = Vu.uw[i].ub[0]; Vd.ub[3*VBITS/32+i] = Vu.uw[i].ub[2] ; }</pre>
<code>Vd.b=vshuff (Vu.b)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i].b[0]=Vu.ub[i]; Vd.uh[i].b[1]=Vu.ub[i+VBITS/16] ; }</pre>
<code>Vd.h=vdeal (Vu.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uh[i] = Vu.uw[i].uh[0]; Vd.uh[i+VBITS/32] = Vu.uw[i].uh[1] ; }</pre>
<code>Vd.h=vshuff (Vu.h)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i].h[0]=Vu.uh[i]; Vd.uw[i].h[1]=Vu.uh[i+VBITS/32] ; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX permute resource.

Intrinsics

<code>Vd.b=vdeal (Vu.b)</code>	HVX_Vector Q6_Vb_vdeal_Vb(HVX_Vector Vu)
<code>Vd.b=vdeale (Vu.b,Vv.b)</code>	HVX_Vector Q6_Vb_vdeale_VbVb(HVX_Vector Vu, HVX_Vector Vv)
<code>Vd.b=vshuff (Vu.b)</code>	HVX_Vector Q6_Vb_vshuff_Vb(HVX_Vector Vu)
<code>Vd.h=vdeal (Vu.h)</code>	HVX_Vector Q6_Vh_vdeal_Vh(HVX_Vector Vu)
<code>Vd.h=vshuff (Vu.h)</code>	HVX_Vector Q6_Vh_vshuff_Vh(HVX_Vector Vu)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.h=vdeal(Vu.h)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	0	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.b=vdeal(Vu.b)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.h=vshuff(Vu.h)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vshuff(Vu.b)
0	0	0	1	1	1	1	1	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.b=vdeale(Vu.b,Vv.b)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

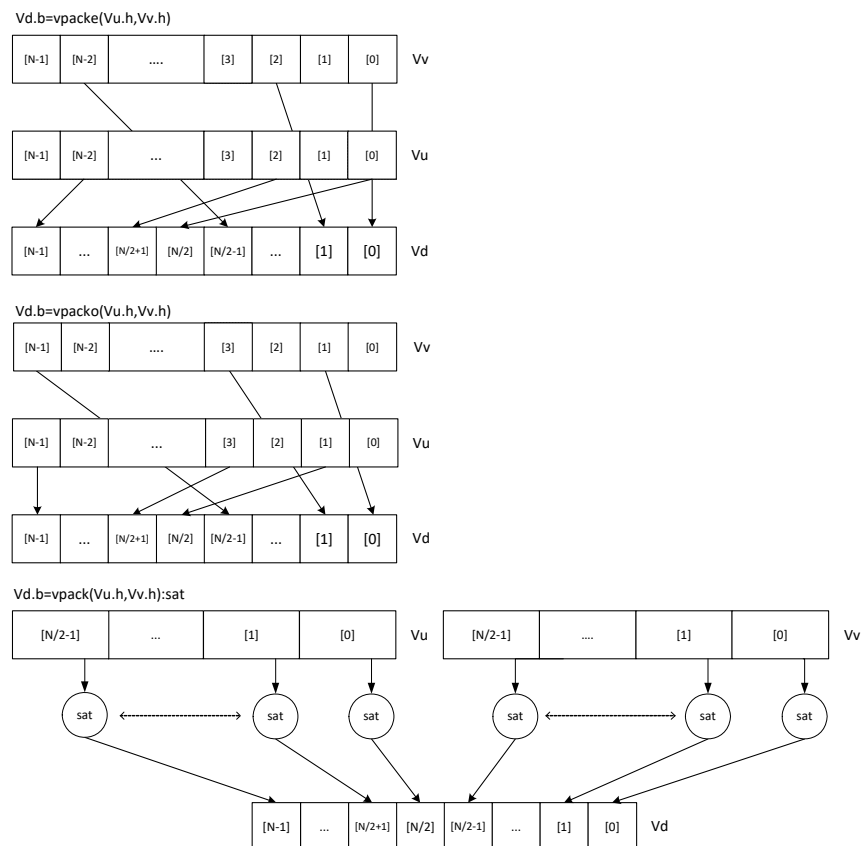
Pack

The vpack operation has three forms. All of them pack elements from the vector registers Vu and Vv into the destination vector register Vd.

The vpacke instruction writes even elements from Vv and Vu into the lower half and upper half of Vd respectively.

The vpacko instruction writes odd elements from Vv and Vu into the lower half and upper half of Vd respectively.

The vpack instruction takes all elements from Vv and Vu, saturates them to the next smallest element size, and writes them into Vd.



Syntax

```
Vd.b=vpack(Vu.h,Vv.h):sat
```

```
Vd.b=vpacke(Vu.h,Vv.h)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.b[i] = sat_8(Vv.h[i]);
    Vd.b[i+VBITS/16] = sat_8(Vu.h[i]) ;
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vd.ub[i] = Vv.uh[i].ub[0];
    Vd.ub[i+VBITS/16] = Vu.uh[i].ub[0] ;
}
```

Syntax	Behavior
<code>Vd.b=vpacko(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.ub[i] = Vv.uh[i].ub[1]; Vd.ub[i+VBITS/16] = Vu.uh[i].ub[1]; }</pre>
<code>Vd.h=vpack(Vu.w,Vv.w):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.h[i] = sat_16(Vv.w[i]); Vd.h[i+VBITS/32] = sat_16(Vu.w[i]); }</pre>
<code>Vd.h=vpacke(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uh[i] = Vv.uw[i].uh[0]; Vd.uh[i+VBITS/32] = Vu.uw[i].uh[0]; }</pre>
<code>Vd.h=vpacko(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uh[i] = Vv.uw[i].uh[1]; Vd.uh[i+VBITS/32] = Vu.uw[i].uh[1]; }</pre>
<code>Vd.ub=vpack(Vu.h,Vv.h):sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.ub[i] = usat_8(Vv.h[i]); Vd.ub[i+VBITS/16] = usat_8(Vu.h[i]); }</pre>
<code>Vd.uh=vpack(Vu.w,Vv.w):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uh[i] = usat_16(Vv.w[i]); Vd.uh[i+VBITS/32] = usat_16(Vu.w[i]); }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX permute resource.

Intrinsics

<code>Vd.b=vpack(Vu.h,Vv.h):sat</code>	<code>HVX_Vector Q6_Vb_vpack_VhVh_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.b=vpacke(Vu.h,Vv.h)</code>	<code>HVX_Vector Q6_Vb_vpacke_VhVh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.b=vpacko(Vu.h,Vv.h)</code>	<code>HVX_Vector Q6_Vb_vpacko_VhVh(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.h=vpack(Vu.w,Vv.w):sat</code>	<code>HVX_Vector Q6_Vh_vpack_VwVw_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.h=vpacke(Vu.w,Vv.w)</code>	<code>HVX_Vector Q6_Vh_vpacke_VwVw(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.h=vpacko(Vu.w,Vv.w)</code>	<code>HVX_Vector Q6_Vh_vpacko_VwVw(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.ub=vpack(Vu.h,Vv.h):sat</code>	<code>HVX_Vector Q6_Vub_vpack_VhVh_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.uh=vpack(Vu.w,Vv.w):sat</code>	<code>HVX_Vector Q6_Vuh_vpack_VwVw_sat(HVX_Vector Vu, HVX_Vector Vv)</code>

Encoding

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		
ICLASS																Parse		u5					d5										
0	0	0	1	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.b=vpacke(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vpacke(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.ub=vpack(Vu.h,Vv.h):sat
0	0	0	1	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.b=vpack(Vu.h,Vv.h):sat
0	0	0	1	1	1	1	1	1	1	1	0	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.uh=vpack(Vu.w,Vv.w):sat
0	0	0	1	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.h=vpack(Vu.w,Vv.w):sat
0	0	0	1	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.b=vpacko(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.h=vpacko(Vu.w,Vv.w)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Set predicate

Set a vector predicate register with a sequence of 1's based on the lower bits of the scalar register Rt.

Rt = 0x11 : Qd4 = 0-----00111111111111111111b

Rt = 0x07 : Qd4 = 0-----00000000000011111111b

The operation is element-size agnostic, and creates a mask to predicate an operation if it does not span a whole vector register width.

Syntax

Qd4=vsetq(Rt)

Qd4=vsetq2(Rt)

Behavior

for(i = 0; i < VWIDTH; i++) QdV[i]=(i < (Rt & (VWIDTH-1))) ? 1 : 0;

for(i = 0; i < VWIDTH; i++) QdV[i]=(i <= ((Rt-1) & (VWIDTH-1))) ? 1 : 0;

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX permute resource.

Intrinsics

Qd4=vsetq(Rt)

Qd4=vsetq2(Rt)

HVX_VectorPred Q6_Q_vsetq_R(Word32 Rt)

HVX_VectorPred Q6_Q_vsetq2_R(Word32 Rt)

Encoding

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	
ICLASS																t5					Parse								d2			
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	-	-	-	-	0	1	0	-	0	1	d	d	Qd4=vsetq(Rt)	
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	0	-	-	-	-	0	1	0	-	1	1	d	d	Qd4=vsetq2(Rt)	

Field name

ICLASS

Parse

d2

t5

Description

Instruction class

Packet/loop parse bits

Field to encode register d

Field to encode register t

Vector in-lane lookup table

The vlut instructions implement fast vectorized lookup-tables. The lookup table is contained in the Vv register while the indexes are held in Vu. Table elements are either 8-bit or 16-bit. An aggregation feature implements tables larger than 64 bytes in 64 byte mode and 128 bytes in 128 byte mode. In both 64 and 128 byte modes, the maximum amount of lookup table accessible is 32 bytes for byte lookups (vlut32) and 16 half words in hwords lookup (vlut16).

8-bit elements

For 64 byte mode, tables with 8-bit elements support 32 entry lookup tables using the vlut32 instructions. The required entry is conditionally selected by using the lower 5 bits of the input byte for the respective output byte. A control input register, Rt, contains match and select bits. The lower 3 bits of Rt must match the upper 3 bits of the input byte index for the table entry to write to or OR with the destination vector register byte in Vd or Vx respectively. The LSB of Rt selects odd or even (32 entry) lookup tables in Vv.

The following example is a 256 byte table stored naturally in memory:

```
127,126,.....66, 65, 64, 63, 62,.....2, 1, 0
255,254,....194,193,192,191,190,.....130,129,128
```

To prepare it for use with the vlut instruction in 64 byte mode, it must be shuffled in blocks of 32 bytes.

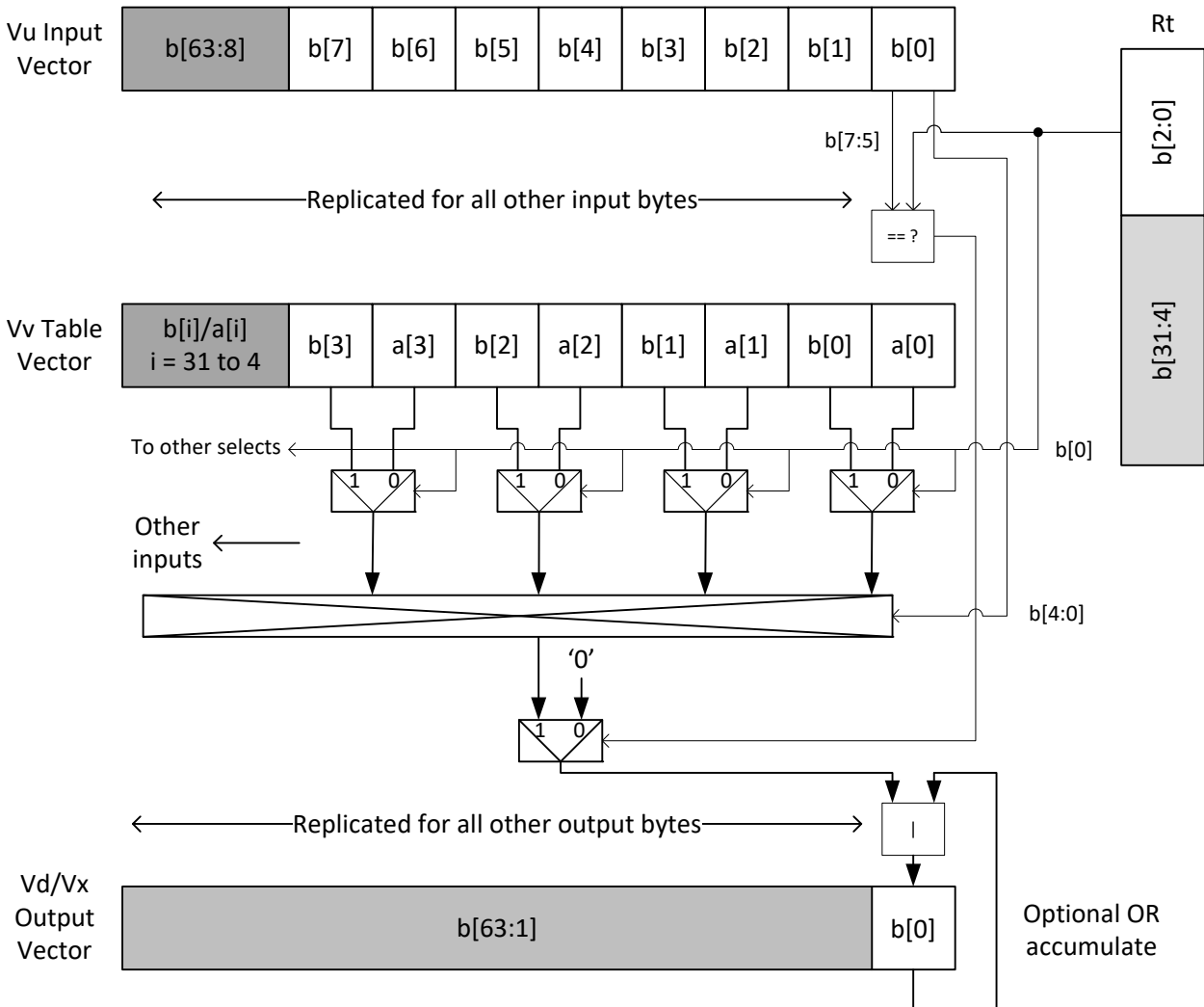
```
63, 31, 62, 30,.....36, 4, 35, 3, 34, 2, 33, 1, 32, 0 Rt=0, Rt=1
127, 95,126, 94,.....100, 68, 99, 67, 98, 66, 97, 65, 96, 64 Rt=2,
Rt=3 same ordering for bytes 128-255 Rt=4, 5, 6, 7
```

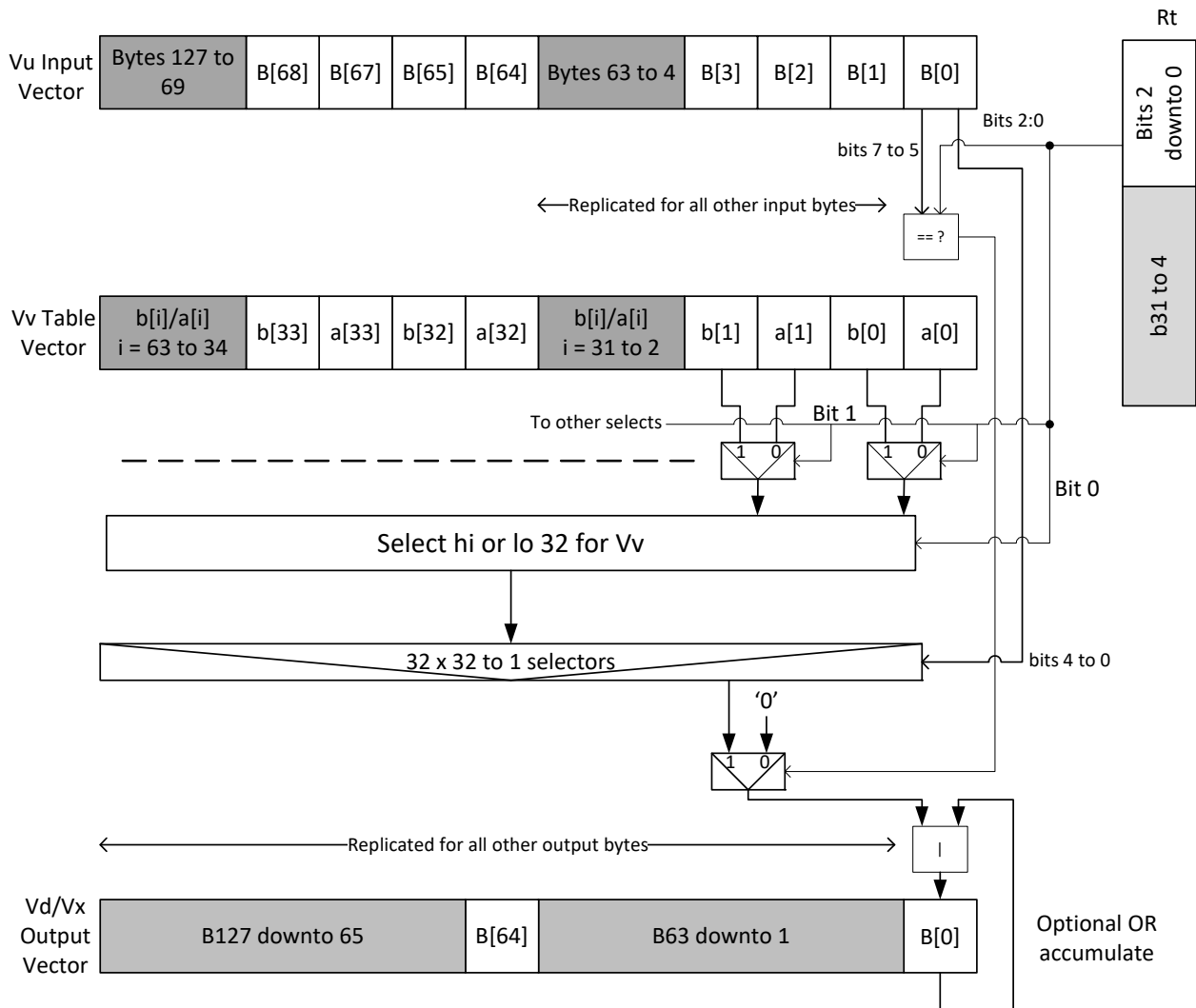
For 128 byte mode, the data must be shuffled in blocks of 64 bytes.

```
127, 63,126, 62,.....68, 4, 67, 3, 66, 2, 65, 1, 64, 0
Rt=0,1,2,3 same ordering for bytes 128-255 Rt=4,5,6,7
```


For data stored in this way, accessing it with 64 or 128 byte mode gives the same results. For 128 byte mode, bit 1 of Rt selects whether to use the odd or even packed table and bit 0 chooses the high or low 32 elements of that high or low table.

$Vd.b = vlut32(Vu.b, Vv.b, Rt)$ and $Vx.b \mid = vlut32(Vu.b, Vv.b, Rt)$



$$Vd.b = vlut32(Vu.b, Vv.b, Rt) \text{ and } Vx.b \mid = vlut32(Vu.b, Vv.b, Rt)$$


128Byte mode

16-bit elements

For tables with 16-bit elements, the basic unit is a 16-entry lookup table in 64 byte mode and 128 byte mode. Supported by the `vlut16` instructions. The even byte entries conditionally select using the lower 4 bits for the even destination register `Vdd0`, the odd byte entries select table entries into the odd vector destination register `Vdd1`. A control input register, `Rt`, contains match and select bits in the same way as the byte table case.

For 64 byte mode, the lower 4 bits of Rt must match the upper four bits of the input bytes for the table entry to write to or OR with the destination vector register bytes in Vdd or Vxx respectively. Bit 0 of Rt selects the even or odd 16 entries in Vv. In the 128 byte case, only the upper four bits of input bytes must also match the lower 4 of Rt. Bit 1 of Rt selects odd or even hwords and bit 0 selects the lower or upper 16 entries in the Vv register.

For larger than 32-element tables in the hword case (for example 256 entries), the user must access the main lookup table in 8 different 32 hword sections.

The following example is a 256 H table stored naturally in memory:

```
63, 62, .....2, 1, 0 127,126, .....66, 65, 64
191,190, .....130,129,128 255,254, .....194,193,192
```

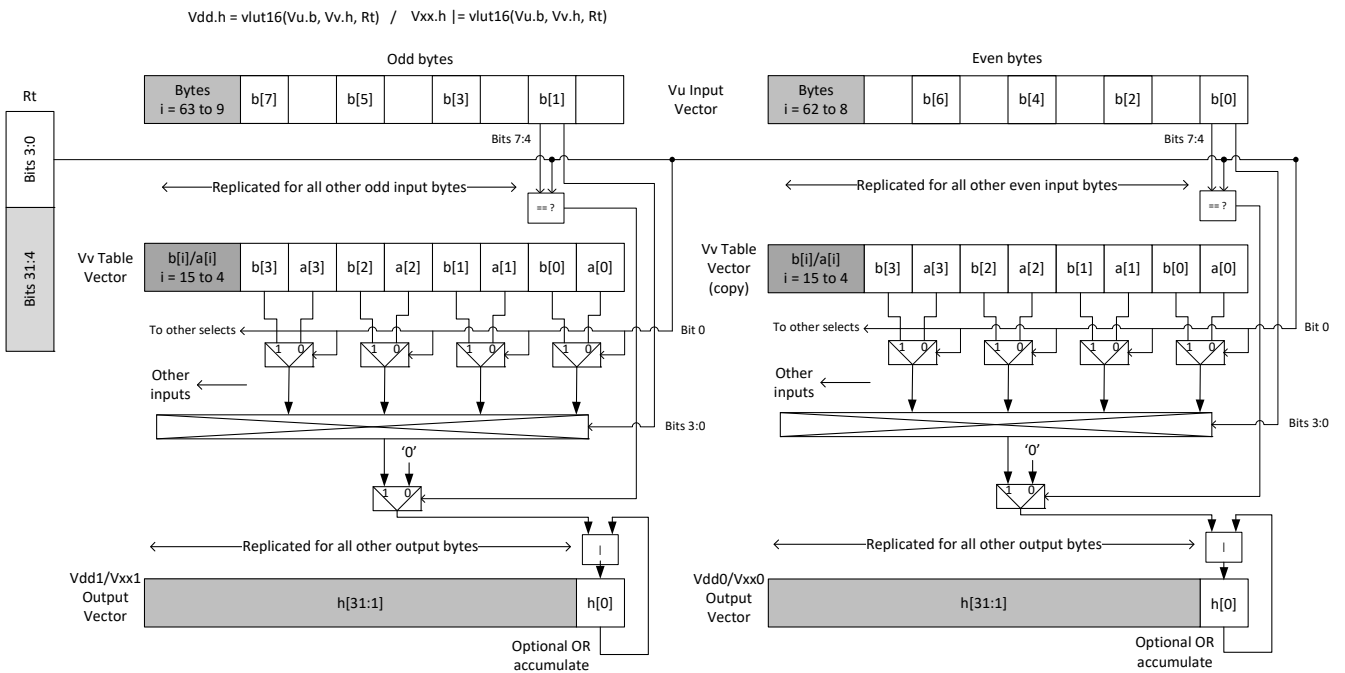
For use with the vlut instruction in 64 byte mode, it must be shuffled in blocks of 16 hwords, the LSB of Rt is used to choose the even or odd 16 entry hword tables in Vv.

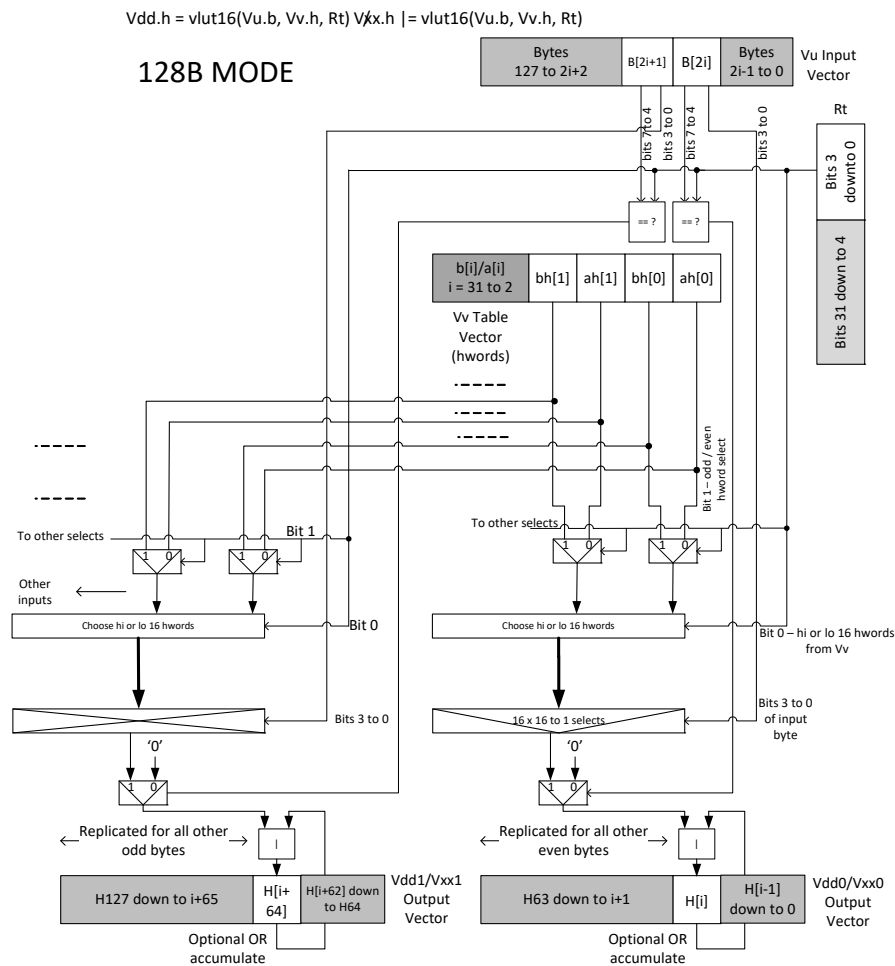
```
31, 15, 30, 14, .....20, 4, 19, 3, 18, 2, 17, 1, 16, 0 Rt=0, Rt=1
63, 47, 62, 46, ..... 52, 36, 51, 35, 50, 34, 49, 33, 48, 32 Rt=2,
Rt=3 same ordering for bytes 64-255 Rt=4, 5, 6, 7, 8, 9,
10,11,12,13,14,15
```

For 128 byte mode, the data must be shuffled in blocks of 32 hwords. Bit 1 of Rt is used to choose between the even or odd 32 hwords in Vv. Bit 0 accesses the high or low 16 half words of the odd or even set.

```
63, 31, 62, 30, .....36, 4, 35, 3, 34, 2, 33, 1, 32, 0 Rt=0,1
Rt=2,3 same ordering for bytes 128-255 Rt=4,5, Rt=6,7, Rt=8,9,
Rt=10,11, Rt=12,13, Rt=14,15
```

The following diagram shows `vlut16` with even bytes used to look up a table value, with the result written into the even destination register. Odd values going into the odd destination, 64 byte and 128 byte modes are shown.





vluts with the nomatch extension do not look at the upper bits and always produce a result. These are for small lookup tables.

Syntax

$Vd.b = vlut32(Vu.b, Vv.b, \#u3)$

$Vd.b = vlut32(Vu.b, Vv.b, Rt)$

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    matchval = #u & 0x7;
    oddhalf = (#u >> (log2(VECTOR_SIZE)-6)) &
0x1;
    idx = Vu.ub[i];
    Vd.b[i] = ((idx & 0xE0) == (matchval << 5)) ?
Vv.h[idx % VBITS/16].b[oddhalf] : 0 ;
}
```

```
for (i = 0; i < VELEM(8); i++) {
    matchval = Rt & 0x7;
    oddhalf = (Rt >> (log2(VECTOR_SIZE)-6)) &
0x1;
    idx = Vu.ub[i];
    Vd.b[i] = ((idx & 0xE0) == (matchval << 5)) ?
Vv.h[idx % VBITS/16].b[oddhalf] : 0 ;
}
```

Syntax

```
Vd.b=vlut32(Vu.b,Vv.b,Rt):nomatch
```

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    matchval = Rt & 0x7;
    oddhalf = (Rt >> (log2(VECTOR_SIZE)-6)) &
0x1;
    idx = Vu.ub[i];
    idx = (idx&0x1F) | (matchval<<5);
    Vd.b[i] = Vv.h[idx % VBITS/16].b[oddhalf] ;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX permute resource.
- Input scalar register Rt is limited to registers 0 through 7

Intrinsics

```
Vd.b=vlut32(Vu.b,Vv.b,#u3)
```

```
HVX_Vector Q6_Vb_vlut32_VbVbI(HVX_Vector Vu,
HVX_Vector Vv, Word32 Iu3)
```

```
Vd.b=vlut32(Vu.b,Vv.b,Rt)
```

```
HVX_Vector Q6_Vb_vlut32_VbVbR(HVX_Vector Vu,
HVX_Vector Vv, Word32 Rt)
```

```
Vd.b=vlut32(Vu.b,Vv.b,Rt):nomatch
```

```
HVX_Vector Q6_Vb_vlut32_VbVbR_nomatch(HVX_Vector
Vu, HVX_Vector Vv, Word32 Rt)
```

Encoding

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	
ICLASS																t3			Parse		u5					d5						
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.b=vlut32(Vu.b,Vv.b,Rt):nomatch
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.b=vlut32(Vu.b,Vv.b,Rt)
ICLASS																Parse			u5					d5								
0	0	0	1	1	1	1	0	0	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	i	i	i	d	d	d	d	d	Vd.b=vlut32(Vu.b,Vv.b,#u3)

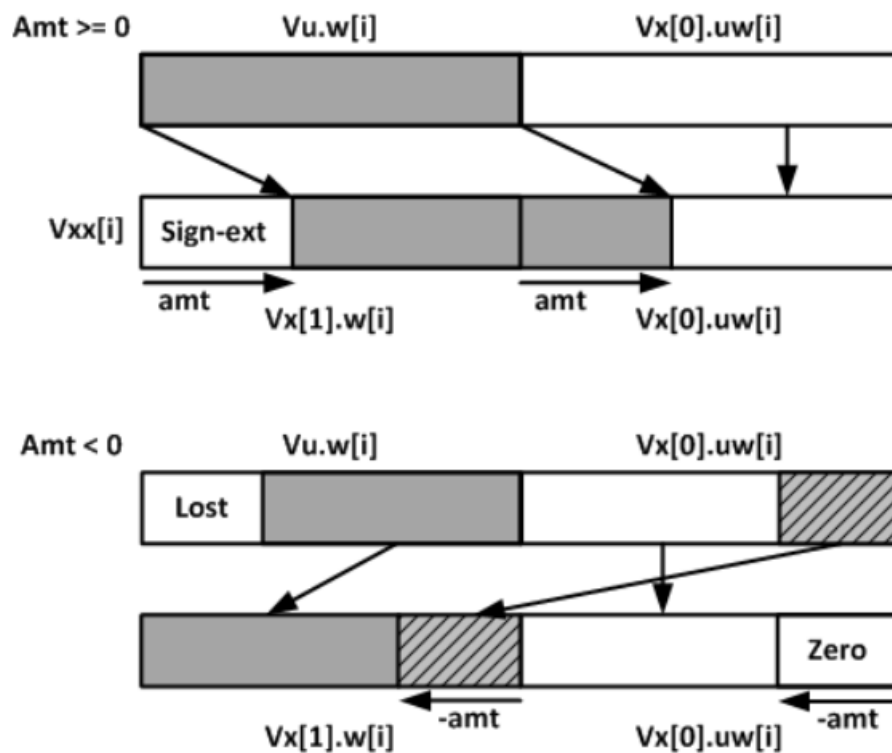
Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t3	Field to encode register t
u5	Field to encode register u
v2	Field to encode register v
v3	Field to encode register v
v5	Field to encode register v

6.11 HVX/PERMUTE-SHIFT-RESOURCE

The HVX/PERMUTE-SHIFT-RESOURCE instruction subclass includes instructions that use both the HVX permute and shift resources.

Vector ASR overlay

The primary use of this instruction is to complete a 64 byte bidirectional ASR by shifting the high-word source ($Vu.w[i]$) and merging with the destination register. This assumes a rotate on the low-word source was already performed and placed in the low-word of the destination register. However, this instruction can also concatenate LSB portions of the source and destination registers and place them into the high or low word of the destination depending on the shift amount.



Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX permute resource.
- This instruction uses the HVX shift resource.

Syntax

```
Vxx.w=vasrinto(Vu.w,Vv.w)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    shift = (Vu.w[i] << 32);
    mask = (((Vxx.v[0].w[i]) << 32) |
Vxx.v[0].w[i]);
    lomask = (((1) << 32) - 1);
    count = -(0x40 & Vv.w[i]) + (Vv.w[i] & 0x3f);
    result = (count == -0x40) ? 0 : (((count < 0)
? ((shift << -(count)) | (mask & (lomask << -
(count)))) : ((shift >> count) | (mask & (lomask
>> count)))));
    Vxx.v[1].w[i] = ((result >> 32) &
0xffffffff);
    Vxx.v[0].w[i] = (result & 0xffffffff) ;
}
```

```
Vxx=vasrinto(Vu,Vv)
```

```
Assembler mapped to: "Vxx.w=vasrinto(Vu.w,Vv.w)"
```

Intrinsics

```
Vxx.w=vasrinto(Vu.w,Vv.w)
```

```
HVX_VectorPair
Q6_Ww_vasrinto_WwVwVw(HVX_VectorPair Vxx,
HVX_Vector Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					x5									
0	0	0	1	1	0	1	0	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	Vxx.w=vasrinto(Vu.w,Vv.w)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
u5	Field to encode register u
v5	Field to encode register v
x5	Field to encode register x

Vector shuffle and deal cross-lane

The `vshuff` (formerly `vtrans2x2`) and `vdeal` instructions perform a multiple-level transpose operation between groups of elements in two vectors.

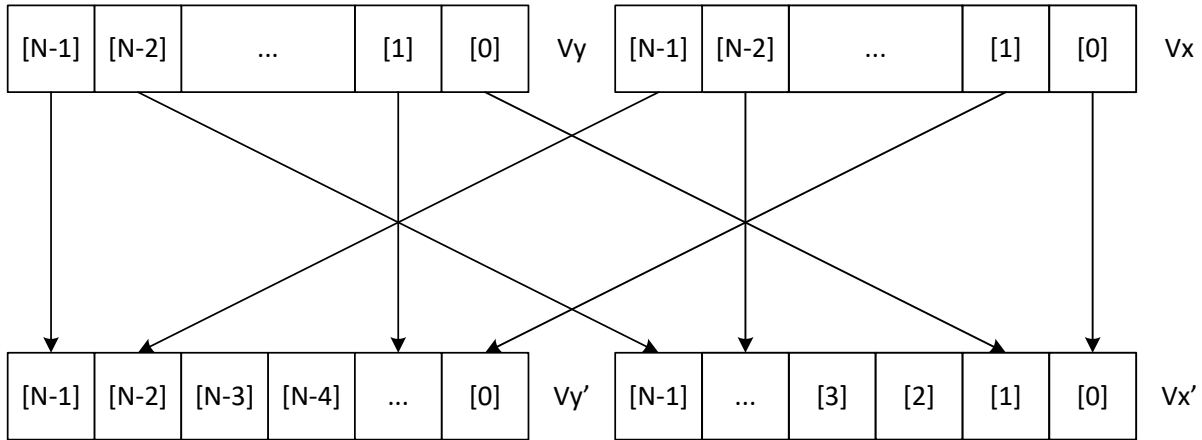
The element size is specified by the scalar register `Rt`:

- `Rt=1` indicates an element size of 1 byte
- `Rt=2` indicates halfwords
- `Rt=4` words, `Rt=8` bytes
- `Rt=16` 16 bytes
- `Rt=32` 32 bytes

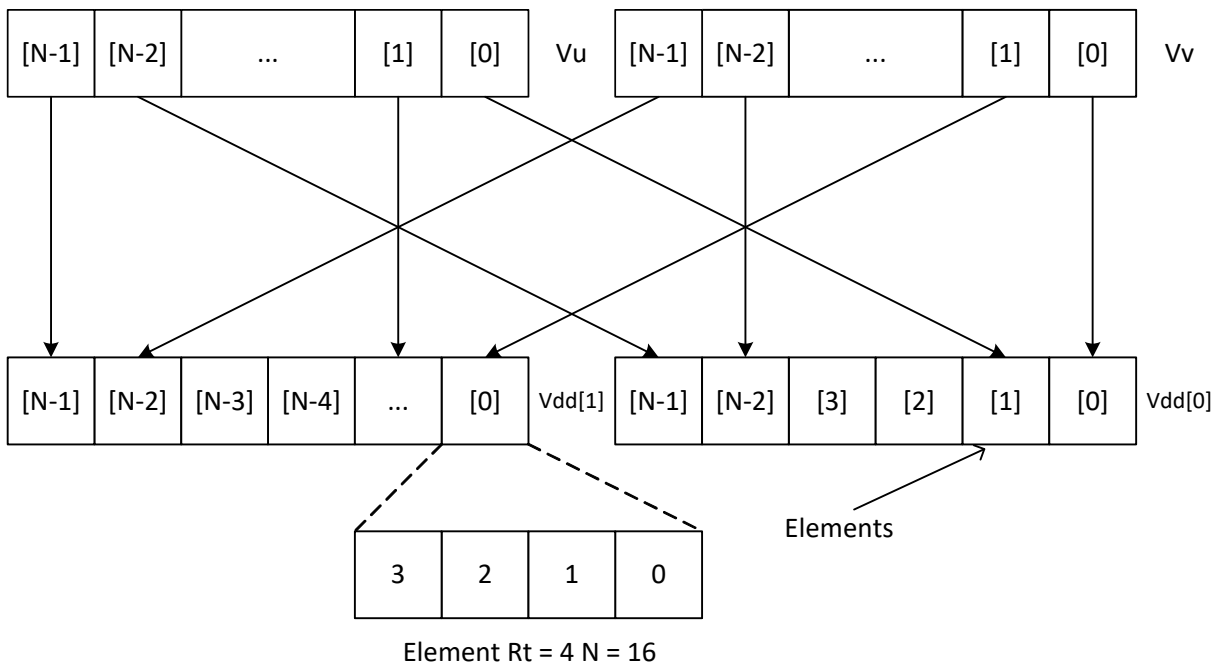
Consider the data in the two registers as two rows of 64 bytes each. Each two-by-two group is transposed. For example, `Rt = 4` indicates that each element contains four bytes. The matrix of four of these elements, made up of two elements from the even register and two corresponding elements of the odd register. This two-by-two array is then transposed, and the resulting elements are then presented in the two destination registers. A value of `Rt = 0` leaves the input unchanged.

Examples for $Rt = 1, 2, 4, 8, 16, 32$ are shown in the following figure. In these cases, `vdeal` and `vshuff` perform the same operation. The diagram is valid for `vshuff` and `vdeal`.

`vshuff/vdeal(Vy, Vx, Rt)` $N = 64/Rt$ $Rt = 2^i$

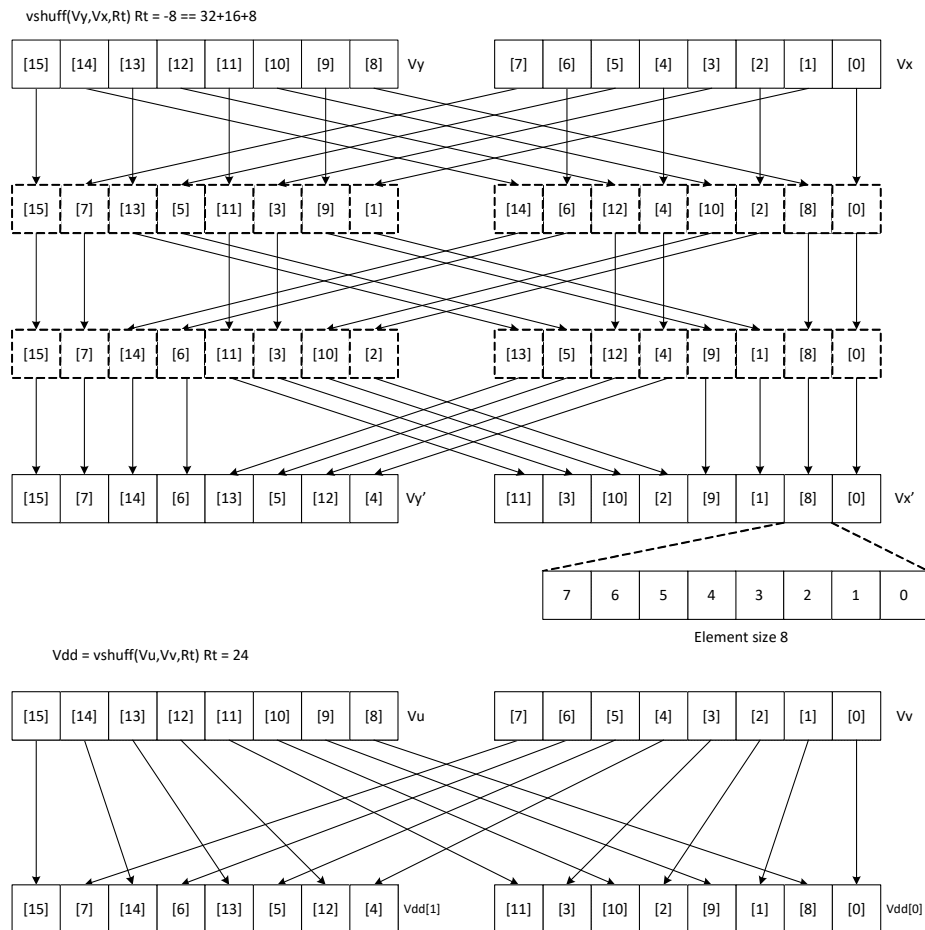


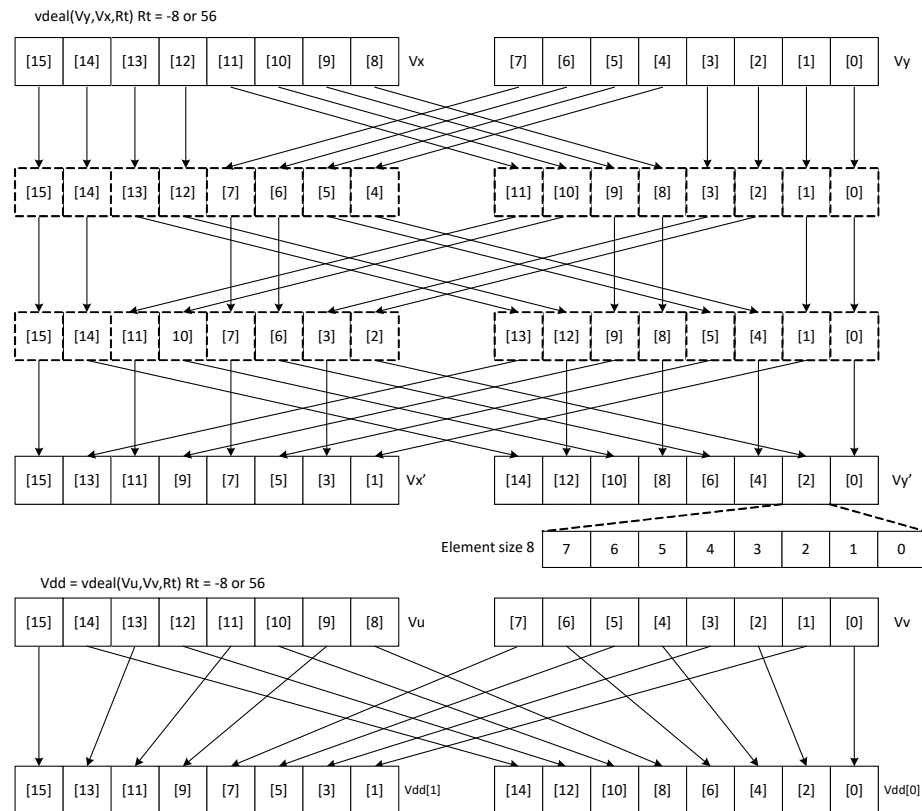
`Vdd = vshuff/vdeal(Vu, Vv, Rt)` $N = 64 / Rt$ $Rt = 2^i$



When a value of Rt other than 1, 2, 4, 8, 16, 32 is used, the effect is a compound hierarchical transpose. For example, if the value 23 is used, $23 = 1 + 2 + 4 + 16$. This indicates that the transformation is the same as performing the `vshuff` instruction with $Rt=1$, then $Rt=2$ on that result, then $Rt=4$ on its result, then $Rt=16$ on its result. The order is in increasing element size. For `vdeal`, the order is reversed, starting with the largest element size first, then working down to the smallest.

When the Rt value is the negated power of 2: $-1, -2, -4, -8, -16, -32$, it performs a perfect shuffle for `vshuff`, or a deal for `vdeal` of the smallest element size. For example, $Rt = -24$ is a multiple of 8, so 8 is the smallest element size. With a -ve value of Rt , the upper bits of the value Rt are set. For example, $Rt = -8$ is the same as $32+16+8$. The following diagram shows the effect of this transform for both `vshuff` and `vdeal`.





If in addition to this family of transformations, a block size is defined B , and the element size is defined as E , then if $Rt = B - E$, the resulting transformation is a set of B contiguous blocks, each containing perfectly shuffled or dealt elements of element size E . Each block B contains $128/B$ elements in the 64 byte vector case. This represents the majority of common data transformations. When B is set to 0, the result is a shuffle or deal of elements across the whole vector register pair.

Syntax

```
Vdd=vdeal (Vu, Vv, Rt)
```

Behavior

```
Vdd.v[0] = Vv;
Vdd.v[1] = Vu;
for (offset=VWIDTH>>1; offset>0; offset>>=1) {
    if ( Rt & offset) {
        for (k = 0; k < VELEM(8); k++) {
            if (!( k & offset)) {
                SWAP(Vdd.v[1].ub[k],Vdd.v[0].ub[
k+offset]);
            }
        }
    }
}
```

Syntax	Behavior
<code>Vdd=vshuff (Vu, Vv, Rt)</code>	<pre> Vdd.v[0] = Vv; Vdd.v[1] = Vu; for (offset=1; offset<VWIDTH; offset<=1) { if (Rt & offset) { for (k = 0; k < VELEM(8); k++) { if (!(k & offset)) { SWAP(Vdd.v[1].ub[k], Vdd.v[0].ub[k+offset]); } } } } </pre>
<code>vdeal (Vy, Vx, Rt)</code>	<pre> for (offset=VWIDTH>>1; offset>0; offset>=1) { if (Rt & offset) { for (k = 0; k < VELEM(8); k++) { if (!(k & offset)) { SWAP(Vy.ub[k], Vx.ub[k+offset]); } } } } </pre>
<code>vshuff (Vy, Vx, Rt)</code>	<pre> for (offset=1; offset<VWIDTH; offset<=1) { if (Rt & offset) { for (k = 0; k < VELEM(8); k++) { if (!(k & offset)) { SWAP(Vy.ub[k], Vx.ub[k+offset]); } } } } </pre>
<code>vtrans2x2 (Vy, Vx, Rt)</code>	Assembler mapped to: <code>"vshuff (Vy, Vx, Rt) "</code>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX permute resource.
- Input scalar register Rt is limited to registers 0 through 7
- This instruction uses the HVX shift resource.

Intrinsics

<code>Vdd=vdeal (Vu, Vv, Rt)</code>	<code>HVX_VectorPair Q6_W_vdeal_VVR(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)</code>
<code>Vdd=vshuff (Vu, Vv, Rt)</code>	<code>HVX_VectorPair Q6_W_vshuff_VVR(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)</code>

Encoding

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		
ICLASS												t5				Parse		y5					x5										
0	0	0	1	1	0	0	1	1	1	1	t	t	t	t	t	P	P	1	y	y	y	y	y	0	0	1	x	x	x	x	x	vshuff(Vy,Vx,Rt)	
0	0	0	1	1	0	0	1	1	1	1	t	t	t	t	t	P	P	1	y	y	y	y	y	0	1	0	x	x	x	x	x	vdeal(Vy,Vx,Rt)	
ICLASS												t3				Parse		u5					d5										
0	0	0	1	1	0	1	1	v	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd=vshuff(Vu,Vv,Rt)
0	0	0	1	1	0	1	1	v	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd=vdeal(Vu,Vv,Rt)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t3	Field to encode register t
t5	Field to encode register t
u5	Field to encode register u
v2	Field to encode register v
v3	Field to encode register v
x5	Field to encode register x
y5	Field to encode register y

Vector in-lane lookup table

The vlut instructions implement fast vectorized lookup-tables. The lookup table is contained in the Vv register while the indexes are held in Vu. Table elements are either 8-bit or 16-bit. An aggregation feature implements tables larger than 64 bytes in 64 byte mode and 128 bytes in 128 byte mode. This explanation discusses both the 64 byte and 128 byte modes of operation. In both 64 and 128 byte modes, the maximum amount of lookup table accessible is 32 bytes for byte lookups (vlut32) and 16 half words in hwords lookup (vlut16).

8-bit elements

For 64 byte mode, tables with 8-bit elements support 32 entry lookup tables using the vlut32 instructions. The required entry is conditionally selected by using the lower five bits of the input byte for the respective output byte. A control input register, Rt, contains match and select bits. The lower three bits of Rt must match the upper three bits of the input byte index for the table entry to write to or OR with the destination vector register byte in Vd or Vx respectively. The LSB of Rt selects odd or even (32 entry) lookup tables in Vv.

The following example is a 256 byte table stored naturally in memory:

```
127,126,.....66, 65, 64, 63, 62,.....2, 1, 0
255,254,....194,193,192,191,190,.....130,129,128
```

For use with the vlut instruction in 64 byte mode it must be shuffled in blocks of 32 bytes

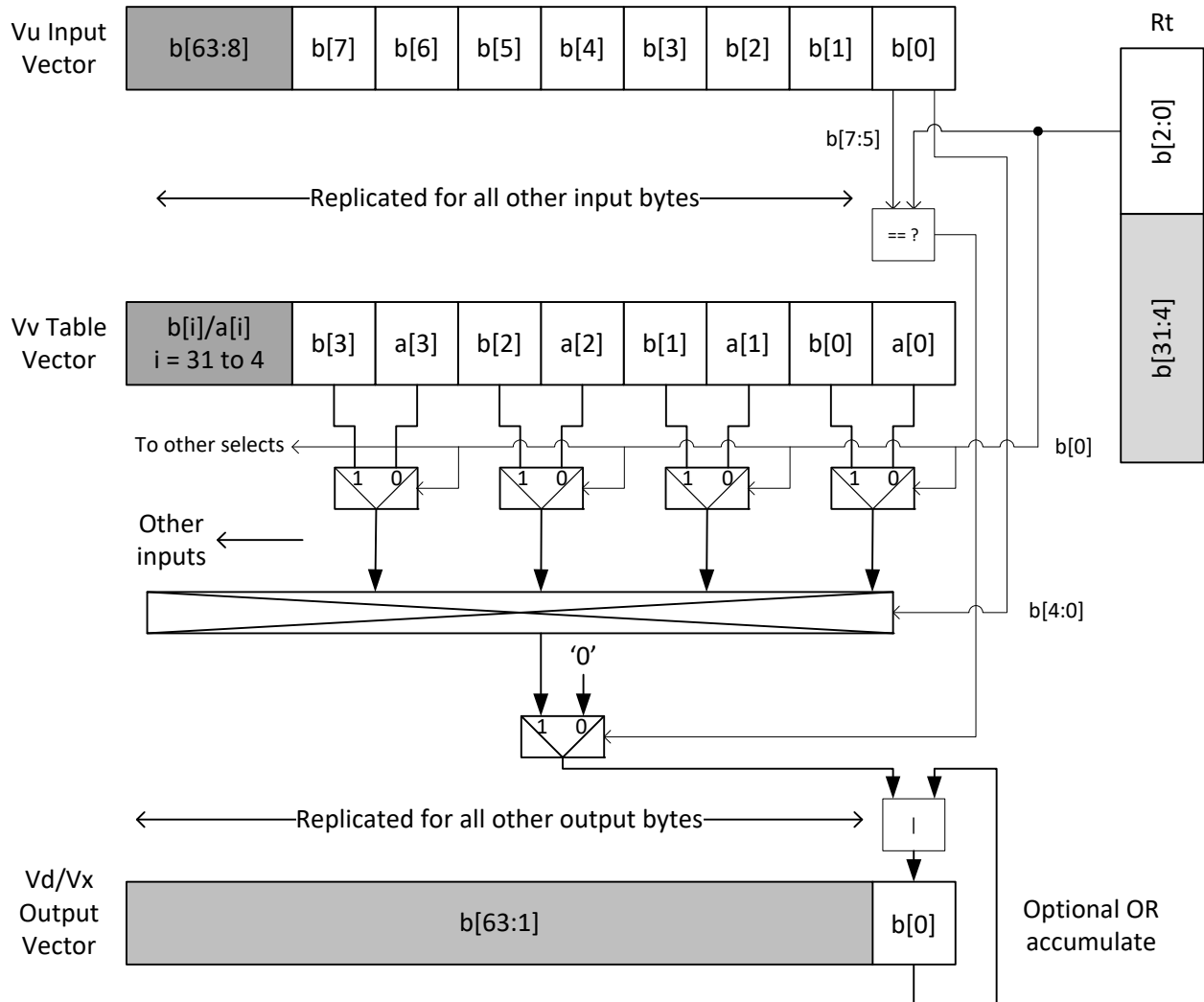
```
63, 31, 62, 30,.....36, 4, 35, 3, 34, 2, 33, 1, 32, 0 Rt=0, Rt=1
127, 95,126, 94,.....100, 68, 99, 67, 98, 66, 97, 65, 96, 64 Rt=2,
Rt=3 same ordering for bytes 128-255 Rt=4, 5, 6, 7
```

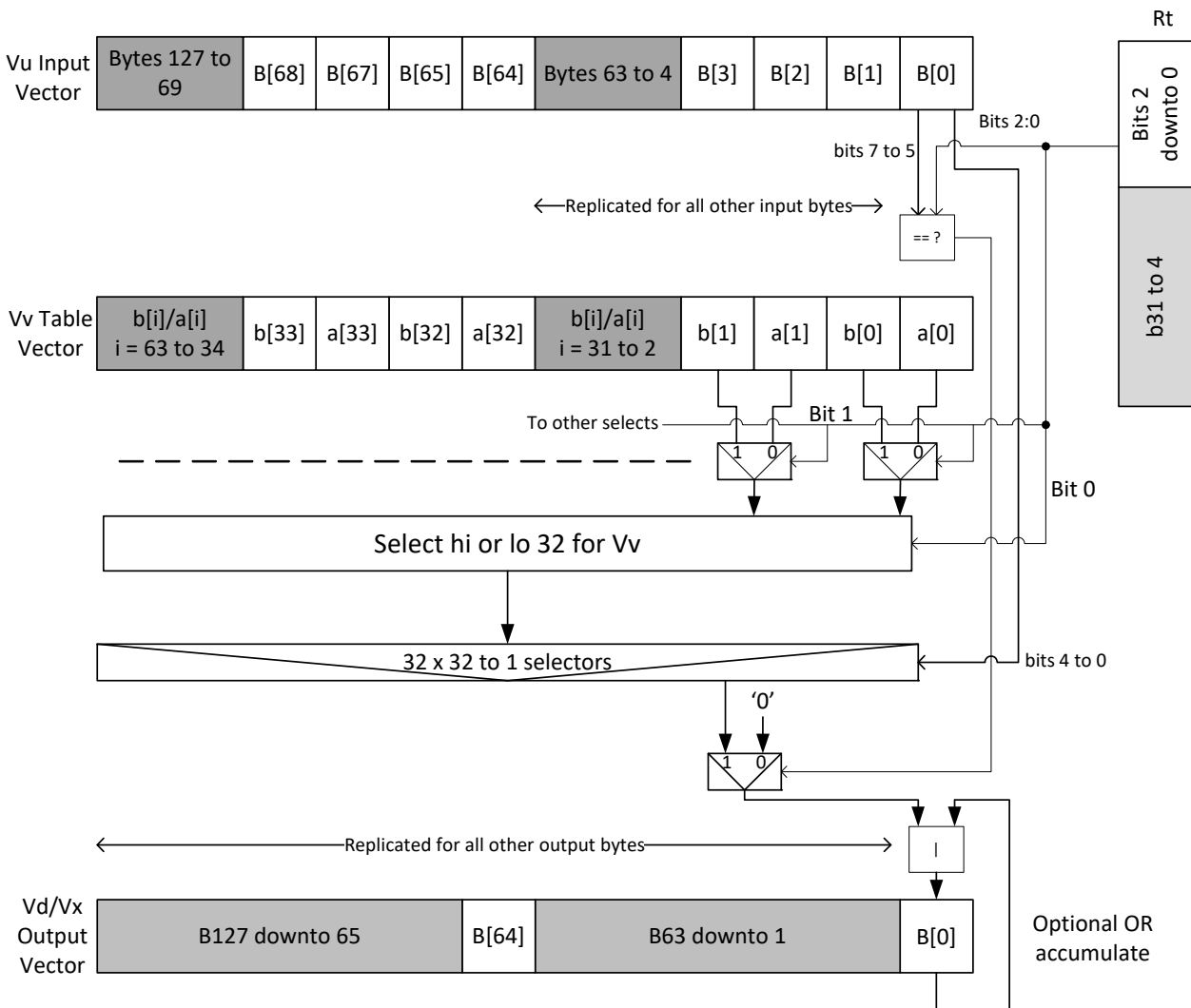
For 128 byte mode, the data must be shuffled in blocks of 64 bytes.

```
127, 63,126, 62,.....68, 4, 67, 3, 66, 2, 65, 1, 64, 0
Rt=0,1,2,3 same ordering for bytes 128-255 Rt=4,5,6,7
```

Accessing data stored in this way with 64 or 128 byte mode gives the same results. For 128 byte mode, bit 1 of Rt selects whether to use the odd or even packed table and bit 0 chooses the high of low 32 elements of that high or low table.

$Vd.b = vlut32(Vu.b, Vv.b, Rt)$ and $Vx.b \mid = vlut32(Vu.b, Vv.b, Rt)$



$$Vd.b = vlut32(Vu.b, Vv.b, Rt) \text{ and } Vx.b |= vlut32(Vu.b, Vv.b, Rt)$$


128Byte mode

16-bit elements

For tables with 16-bit elements, the basic unit is a 16-entry lookup table in 64 byte mode and 128 byte mode. Supported by the `vlut16` instructions. The even byte entries conditionally select using the lower four bits for the even destination register `Vdd0`, the odd byte entries select table entries into the odd vector destination register `Vdd1`. A control input register, `Rt`, contains match and select bits in the same way as the byte table case.

For 64 byte mode, the lower 4 bits of `Rt` must match the upper four bits of the input bytes for the table entry to write to or OR with the destination vector register bytes in `Vdd0` or `Vx`, respectively. Bit 0 of `Rt` selects the even or odd 16 entries in `Vv`. In the 128 byte case, only the upper four bits of input bytes must also match the lower four bits of `Rt`.

Bit 1 of Rt selects odd or even hwords, and bit 0 selects the lower or upper 16 entries in the Vv register.

For larger than 32-element tables in the hword case (for example 256 entries), the user must access the main lookup table in 8 different 32 hword sections.

The following example is a 256 H table stored naturally in memory:

```
63, 62, .....2, 1, 0 127,126, .....66, 65, 64
191,190, .....130,129,128 255,254, .....194,193,192
```

For use with the vlut instruction in 64 byte mode, it must be shuffled in blocks of 16 hwords. The LSB of Rt is used to choose the even or odd 16 entry hword tables in Vv.

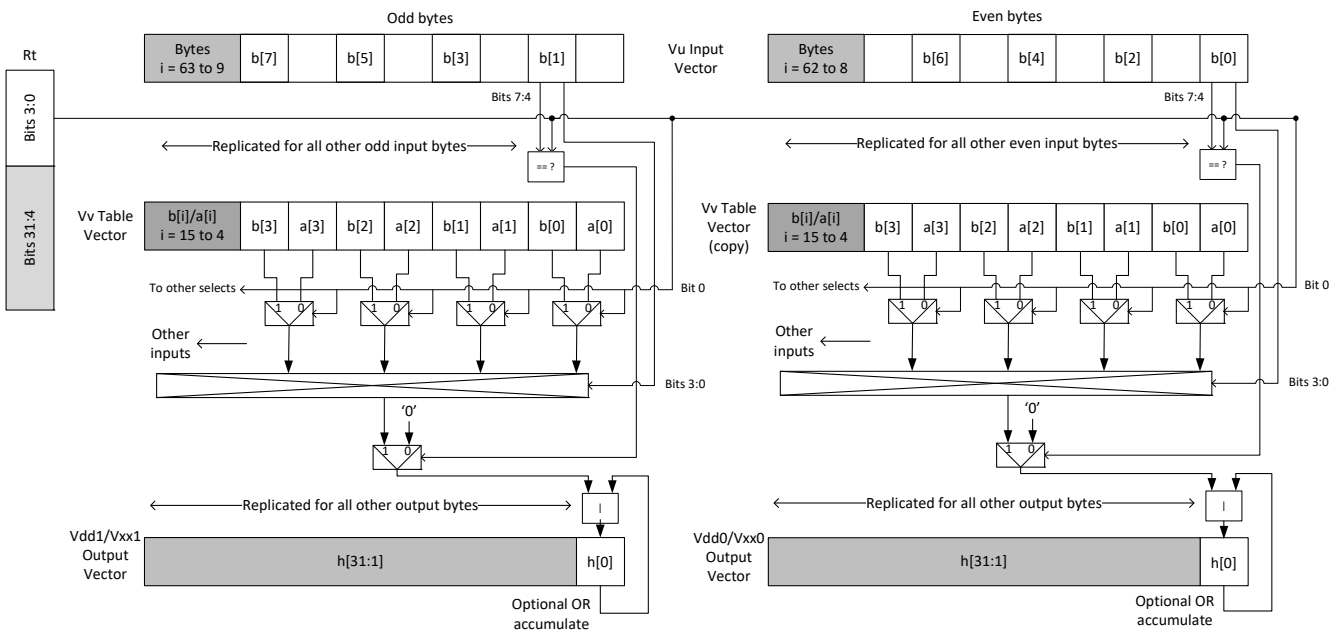
```
31, 15, 30, 14, .....20, 4, 19, 3, 18, 2, 17, 1, 16, 0 Rt=0, Rt=1
63, 47, 62, 46, ..... 52, 36, 51, 35, 50, 34, 49, 33, 48, 32 Rt=2,
Rt=3 same ordering for bytes 64-255 Rt=4, 5, 6, 7, 8, 9,
10,11,12,13,14,15
```

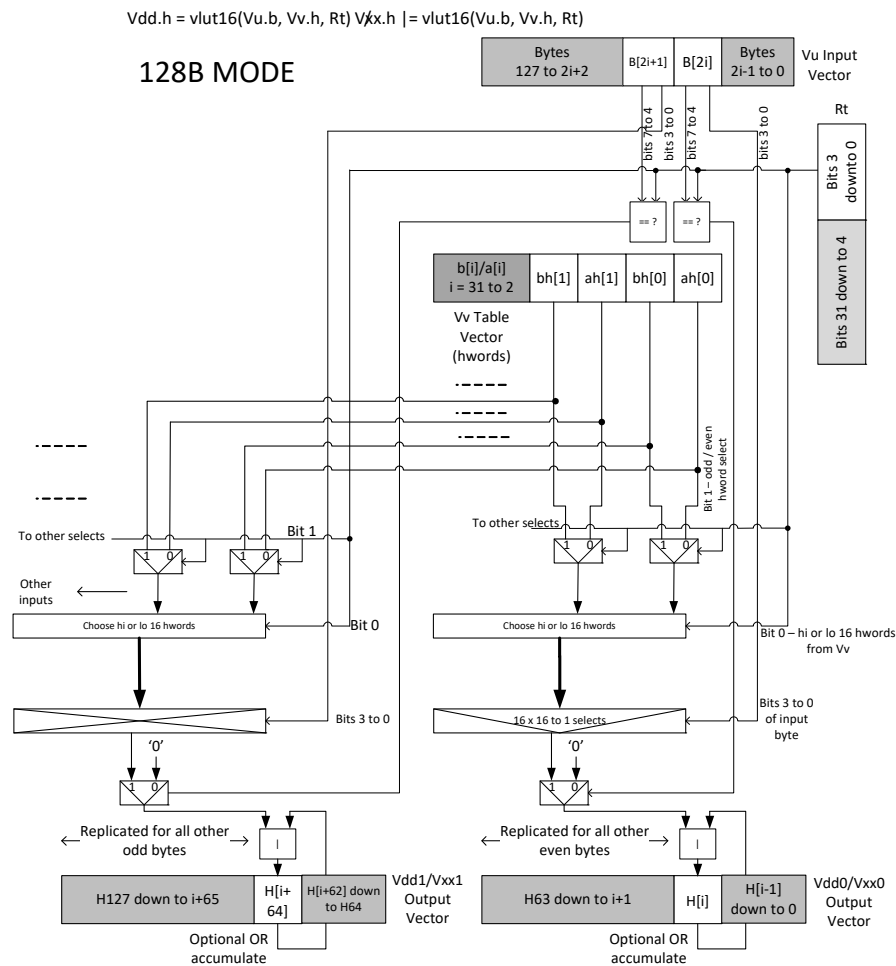
For 128 byte mode, the data must be shuffled in blocks of 32 hwords. Bit 1 of Rt is used to choose between the even or odd 32 hwords in Vv. Bit 0 accesses the high or low 16 half words of the odd or even set.

```
63, 31, 62, 30, .....36, 4, 35, 3, 34, 2, 33, 1, 32, 0 Rt=0,1
Rt=2,3 same ordering for bytes 128-255 Rt=4,5, Rt=6,7, Rt=8,9,
Rt=10,11, Rt=12,13, Rt=14,15
```

The following diagram shows vlut16 with even bytes used to look up a table value, with the result written into the even destination register. Odd values go into the odd destination, 64 byte and 128 byte modes are shown.

$$Vdd.h = vlut16(Vu.b, Vv.h, Rt) / Vxx.h = vlut16(Vu.b, Vv.h, Rt)$$





Vluts with the nomatch extension do not look at the upper bits and always produce a result. These are for small lookup tables.

Syntax

```
Vdd.h=vlut16(Vu.b,Vv.h,#u3)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    matchval = #u & 0xF;
    oddhalf = (#u >> (log2(VECTOR_SIZE)-6)) &
    0x1;
    idx = Vu.uh[i].ub[0];
    Vdd.v[0].h[i] = ((idx & 0xF0) == (matchval
    << 4)) ? Vv.w[idx % VBITS/32].h[oddhalf] : 0;
    idx = Vu.uh[i].ub[1];
    Vdd.v[1].h[i] = ((idx & 0xF0) == (matchval
    << 4)) ? Vv.w[idx % VBITS/32].h[oddhalf] : 0;
}
```

Syntax	Behavior
<code>Vdd.h=vlut16(Vu.b,Vv.h,Rt)</code>	<pre> for (i = 0; i < VELEM(16); i++) { matchval = Rt & 0xF; oddhalf = (Rt >> (log2(VECTOR_SIZE)-6)) & 0x1; idx = Vu.uh[i].ub[0]; Vdd.v[0].h[i] = ((idx & 0xF0) == (matchval << 4)) ? Vv.w[idx % VBITS/32].h[oddhalf] : 0; idx = Vu.uh[i].ub[1]; Vdd.v[1].h[i] = ((idx & 0xF0) == (matchval << 4)) ? Vv.w[idx % VBITS/32].h[oddhalf] : 0 ; } </pre>
<code>Vdd.h=vlut16(Vu.b,Vv.h,Rt):nomat tch</code>	<pre> for (i = 0; i < VELEM(16); i++) { matchval = Rt & 0xF; oddhalf = (Rt >> (log2(VECTOR_SIZE)-6)) & 0x1; idx = Vu.uh[i].ub[0]; idx = (idx&0x0F) (matchval<<4); Vdd.v[0].h[i] = Vv.w[idx % VBITS/32].h[oddhalf]; idx = Vu.uh[i].ub[1]; idx = (idx&0x0F) (matchval<<4); Vdd.v[1].h[i] = Vv.w[idx % VBITS/32].h[oddhalf] ; } </pre>
<code>Vx.b =vlut32(Vu.b,Vv.b,#u3)</code>	<pre> for (i = 0; i < VELEM(8); i++) { matchval = #u & 0x7; oddhalf = (#u >> (log2(VECTOR_SIZE)-6)) & 0x1; idx = Vu.ub[i]; Vx.b[i] = ((idx & 0xE0) == (matchval << 5)) ? Vv.h[idx % VBITS/16].b[oddhalf] : 0 ; } </pre>
<code>Vx.b =vlut32(Vu.b,Vv.b,Rt)</code>	<pre> for (i = 0; i < VELEM(8); i++) { matchval = Rt & 0x7; oddhalf = (Rt >> (log2(VECTOR_SIZE)-6)) & 0x1; idx = Vu.ub[i]; Vx.b[i] = ((idx & 0xE0) == (matchval << 5)) ? Vv.h[idx % VBITS/16].b[oddhalf] : 0 ; } </pre>
<code>Vxx.h =vlut16(Vu.b,Vv.h,#u3)</code>	<pre> for (i = 0; i < VELEM(16); i++) { matchval = #u & 0xF; oddhalf = (#u >> (log2(VECTOR_SIZE)-6)) & 0x1; idx = Vu.uh[i].ub[0]; Vxx.v[0].h[i] = ((idx & 0xF0) == (matchval << 4)) ? Vv.w[idx % VBITS/32].h[oddhalf] : 0; idx = Vu.uh[i].ub[1]; Vxx.v[1].h[i] = ((idx & 0xF0) == (matchval << 4)) ? Vv.w[idx % VBITS/32].h[oddhalf] : 0 ; } </pre>

Syntax

```
Vxx.h|=vlut16(Vu.b,Vv.h,Rt)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    matchval = Rt.ub[0] & 0xF;
    odddhalf = (Rt >> (log2(VECTOR_SIZE)-6)) &
0x1;
    idx = Vu.uh[i].ub[0];
    Vxx.v[0].h[i] |= ((idx & 0xF0) == (matchval
<< 4)) ? Vv.w[idx % VBITS/32].h[odddhalf] : 0;
    idx = Vu.uh[i].ub[1];
    Vxx.v[1].h[i] |= ((idx & 0xF0) == (matchval
<< 4)) ? Vv.w[idx % VBITS/32].h[odddhalf] : 0;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX permute resource.
- Input scalar register Rt is limited to registers 0 through 7
- This instruction uses the HVX shift resource.

Intrinsics

Vdd.h =vlut16(Vu.b,Vv.h,#u3)	HVX_VectorPair Q6_Wh_vlut16_VbVhI (HVX_Vector Vu, HVX_Vector Vv, Word32 Iu3)
Vdd.h =vlut16(Vu.b,Vv.h,Rt)	HVX_VectorPair Q6_Wh_vlut16_VbVhR (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vdd.h =vlut16(Vu.b,Vv.h,Rt):nomatch	HVX_VectorPair Q6_Wh_vlut16_VbVhR_nomatch (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vx.b =vlut32(Vu.b,Vv.b,#u3)	HVX_Vector Q6_Vb_vlut32or_VbVbVbI (HVX_Vector Vx, HVX_Vector Vu, HVX_Vector Vv, Word32 Iu3)
Vx.b =vlut32(Vu.b,Vv.b,Rt)	HVX_Vector Q6_Vb_vlut32or_VbVbVbR (HVX_Vector Vx, HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vxx.h =vlut16(Vu.b,Vv.h,#u3)	HVX_VectorPair Q6_Wh_vlut16or_WhVbVhI (HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv, Word32 Iu3)
Vxx.h =vlut16(Vu.b,Vv.h,Rt)	HVX_VectorPair Q6_Wh_vlut16or_WhVbVhR (HVX_VectorPair Vxx, HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)

Encoding

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	
ICLASS														t3			Parse		u5					d5								
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vdd.h =vlut16(Vu.b,Vv.h,Rt):nomatch
ICLASS														t3			Parse		u5					x5								
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vx.b =vlut32(Vu.b,Vv.b,Rt)
ICLASS														t3			Parse		u5					d5								

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	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	1	0	d	d	d	d	d	Vdd.h=vlut16(Vu.b,Vv.h,Rt)
ICLASS														t3			Parse			u5					x5							
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	Vxx.h=vlut16(Vu.b,Vv.h,Rt)
ICLASS														Parse			u5					x5										
0	0	0	1	1	1	0	0	1	1	0	v	v	v	v	v	P	P	1	u	u	u	u	u	i	i	i	x	x	x	x	x	Vx.b =vlut32(Vu.b,Vv.b,#u3)
0	0	0	1	1	1	0	0	1	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	i	i	i	x	x	x	x	x	Vxx.h =vlut16(Vu.b,Vv.h,#u3)
ICLASS														Parse			u5					d5										
0	0	0	1	1	1	1	0	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	i	i	i	d	d	d	d	d	Vdd.h=vlut16(Vu.b,Vv.h,#u3)

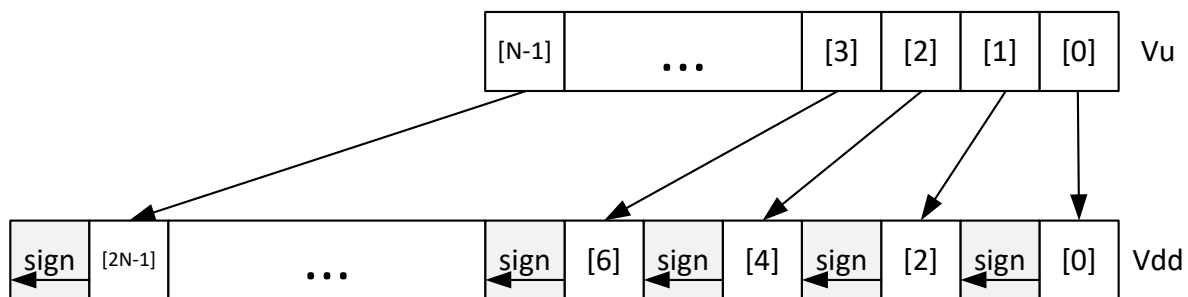
Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t3	Field to encode register t
u5	Field to encode register u
v2	Field to encode register v
v3	Field to encode register v
v5	Field to encode register v
x5	Field to encode register x

Unpack

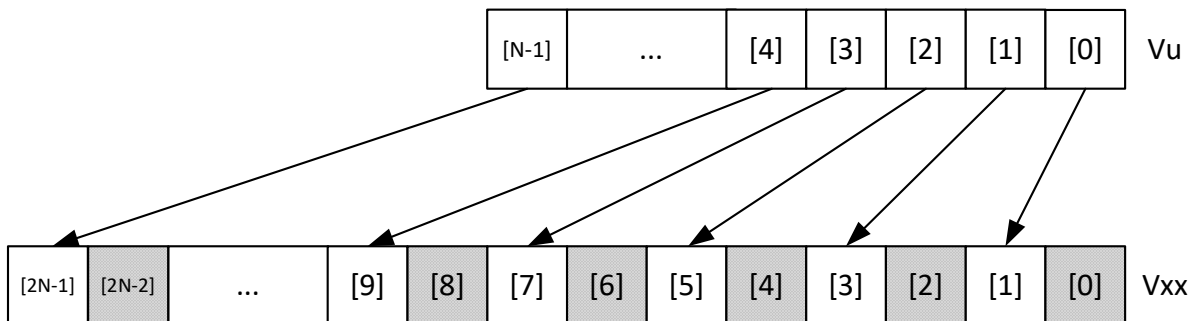
The unpack operation has two forms. The first form takes each element in vector register V_u and either zero or sign extends it to the next largest element size. The results are written into the vector register V_{dd} . This operation supports the unpacking of signed or unsigned byte to halfword, signed or unsigned halfword to word, and unsigned word to unsigned double.

The second form inserts elements from V_u into the odd element locations of V_{xx} . The even elements of V_{xx} are not changed. This operation supports the unpacking of signed or unsigned byte to halfword, and signed or unsigned halfword to word.

$V_{dd}.h = \text{vunpack}(V_u.b)$



$V_{xx}.h = \text{vunpacko}(V_u.b)$



Unmodified

Syntax

$V_{dd}.h = \text{vunpack}(V_u.b)$

$V_{dd}.uh = \text{vunpack}(V_u.ub)$

$V_{dd}.uw = \text{vunpack}(V_u.uh)$

Behavior

```
for (i = 0; i < VELEM(8); i++) {
    Vdd.h[i] = Vu.b[i];
}
```

```
for (i = 0; i < VELEM(8); i++) {
    Vdd.uh[i] = Vu.ub[i];
}
```

```
for (i = 0; i < VELEM(16); i++) {
    Vdd.uw[i] = Vu.uh[i];
}
```

Syntax	Behavior
Vdd.w=vunpack(Vu.h)	for (i = 0; i < VELEM(16); i++) { Vdd.w[i] = Vu.h[i] ; }
Vxx.h =vunpacko(Vu.b)	for (i = 0; i < VELEM(8); i++) { Vxx.uh[i] = Vu.ub[i]<<8 ; }
Vxx.w =vunpacko(Vu.h)	for (i = 0; i < VELEM(16); i++) { Vxx.uw[i] = Vu.uh[i]<<16 ; }

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX permute resource.
- This instruction uses the HVX shift resource.

Intrinsics

Vdd.h=vunpack(Vu.b)	HVX_VectorPair Q6_Wh_vunpack_Vb(HVX_Vector Vu)
Vdd.uh=vunpack(Vu.ub)	HVX_VectorPair Q6_Wuh_vunpack_Vub(HVX_Vector Vu)
Vdd.uw=vunpack(Vu.uh)	HVX_VectorPair Q6_Wuw_vunpack_Vuh(HVX_Vector Vu)
Vdd.w=vunpack(Vu.h)	HVX_VectorPair Q6_Ww_vunpack_Vh(HVX_Vector Vu)
Vxx.h =vunpacko(Vu.b)	HVX_VectorPair Q6_Wh_vunpackoor_WhVb(HVX_VectorPair Vxx, HVX_Vector Vu)
Vxx.w =vunpacko(Vu.h)	HVX_VectorPair Q6_Ww_vunpackoor_WwVh(HVX_VectorPair Vxx, HVX_Vector Vu)

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vdd.uh=vunpack(Vu.ub)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vdd.uw=vunpack(Vu.uh)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vdd.h=vunpack(Vu.b)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	0	1	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vdd.w=vunpack(Vu.h)
ICLASS																Parse		u5					x5									
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	u	u	u	u	u	0	0	0	x	x	x	x	x	Vxx.h =vunpacko(Vu.b)
0	0	0	1	1	1	1	0	-	-	0	-	-	0	0	0	P	P	1	u	u	u	u	u	0	0	1	x	x	x	x	x	Vxx.w =vunpacko(Vu.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits

Field name	Description
d5	Field to encode register d
u5	Field to encode register u
x5	Field to encode register x

6.12 HVX/SCATTER-DOUBLE-RESOURCE

The HVX/SCATTER-DOUBLE-RESOURCE instruction subclass includes instructions that perform scatter operations to the vector TCM.

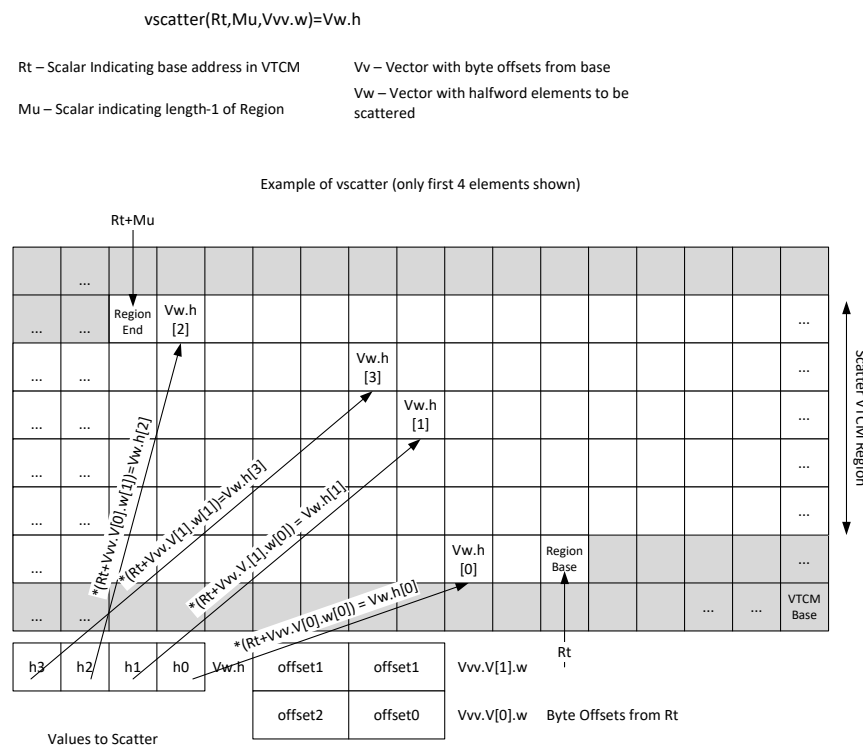
Vector scatter

Scatter operations copy values from the register file to a region in VTCM. Two scalar registers specify this region of memory: $Rt32$ is the base and $Mu2$ specified the length-1 of the region in bytes. This region must reside in VTCM and cannot cross a page boundary. A vector register, $Vvv32$, specifies byte offsets in this region. Elements of either halfword or word granularity, specified by $Vw32$, are sent to addresses pointed to by $Rt + Vvv32$ for each element. In the memory, the element is either write to memory or accumulated with the memory (scatter-accumulate).

If multiple values are written to the same memory location, ordering is not guaranteed. This applies to a single scatter or multiple scatters.

The offset vector, $Vvv32$, can contain byte offsets specified in word sizes. The vector pair contains even element offsets in the lower vector and the odd in the upper vector. The final element addresses do not have to be byte aligned for regular scatter operations. However, for scatter accumulate instructions, the addresses are aligned. If an offset crosses the scatter region's end, it is dropped. Offsets must be positive otherwise they are dropped.

All vectors registers can be used immediately after the scatter operation.



Syntax	Behavior
<pre>if (Qs4) vscatter (Rt, Mu, Vvv.w) .h=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { for(j = 0; j < 2; j++) { EA = Rt+Vvv.v[j].uw[i]; if ((Rt <= EA <= Rt + MuV) & QsV) *EA = VwV.w[i].uh[j]; } }</pre>
<pre>if (Qs4) vscatter (Rt, Mu, Vvv.w) =Vw32.h</pre>	Assembler mapped to: "if (Qs4) vscatter (Rt, Mu2, Vvv.w) .h=Vw32"
<pre>vscatter (Rt, Mu, Vvv.w) +=Vw32.h</pre>	Assembler mapped to: "vscatter (Rt, Mu2, Vvv.w) .h+=Vw32"
<pre>vscatter (Rt, Mu, Vvv.w) .h+=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { for(j = 0; j < 2; j++) { EA = Rt + Vvv.v[j].uw[i] = Vvv.v[j].uw[i] & ~(ALIGNMENT-1); if (Rt <= EA <= Rt + MuV) *EA += VwV.w[i].uh[j]; } }</pre>
<pre>vscatter (Rt, Mu, Vvv.w) .h=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { for(j = 0; j < 2; j++) { EA = Rt+Vvv.v[j].uw[i]; if (Rt <= EA <= Rt + MuV) *EA = VwV.w[i].uh[j]; } }</pre>
<pre>vscatter (Rt, Mu, Vvv.w) =Vw32.h</pre>	Assembler mapped to: "vscatter (Rt, Mu2, Vvv.w) .h=Vw32"

Class: COPROC_VMEM (slots 0)

Notes

- This instruction uses any pair of the HVX resources (both multiply or shift/permute).

Intrinsics

<pre>if (Qs4) vscatter (Rt, Mu, Vvv.w) .h=Vw32</pre>	<pre>void Q6_vscatter_QRMWwV(HVX_VectorPred Qs, HVX_Vector* Rb, Word32 Mu, HVX_VectorPair Vvv, HVX_Vector Vw)</pre>
<pre>vscatter (Rt, Mu, Vvv.w) .h+=Vw32</pre>	<pre>void Q6_vscatteracc_RMWwV(HVX_Vector* Rb, Word32 Mu, HVX_VectorPair Vvv, HVX_Vector Vw)</pre>
<pre>vscatter (Rt, Mu, Vvv.w) .h=Vw32</pre>	<pre>void Q6_vscatter_RMWwV(HVX_Vector* Rb, Word32 Mu, HVX_VectorPair Vvv, HVX_Vector Vw)</pre>

Encoding

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	
ICLASS									NT	t5					Parse		u1															
0	0	1	0	1	1	1	1	0	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	0	1	0	w	w	w	w	w	vscatter(Rt,Mu,Vvv.w).h=Vw32
0	0	1	0	1	1	1	1	0	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	1	1	0	w	w	w	w	w	vscatter(Rt,Mu,Vvv.w).h+=Vw32
ICLASS									NT	t5					Parse		u1											s2				
0	0	1	0	1	1	1	1	1	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	0	s	s	w	w	w	w	w	if (Qs4) vscatter(Rt,Mu,Vvv.w).h=Vw32

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s2	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v5	Field to encode register v

6.13 HVX/SCATTER

The HVX/SCATTER instruction subclass includes instructions that perform scatter operations to the vector TCM.

Vector scatter

Scatter operations copy values from the register file to a region in VTCM. This region of memory is specified by two scalar registers: Rt32 is the base and Mu2 specified the length-1 of the region in bytes. This region must reside in VTCM and cannot cross a page boundary. A vector register, Vv32, specifies byte offsets in this region. Elements of either halfword or word granularity, specified by Vw32, are sent to addresses pointed to by Rt + Vv32 for each element. In the memory, the element is either write to memory or accumulated with the memory (scatter-accumulate).

If multiple values are written to the same memory location, ordering is not guaranteed.

The offset vector, Vv32, can contain byte offsets specified in either halfword or word sizes. The final element addresses do not have to be byte aligned for regular scatter operations. However, for scatter accumulate instructions, the addresses are aligned. If an offset crosses the scatter region's end, it is dropped. Offsets must be positive, otherwise they are dropped.

All vectors registers can be used immediately after the scatter operation.

$$\text{vscatter}(\text{Rt}, \text{Mu}, \text{Vv}, \text{h}) = \text{Vw}, \text{h}$$

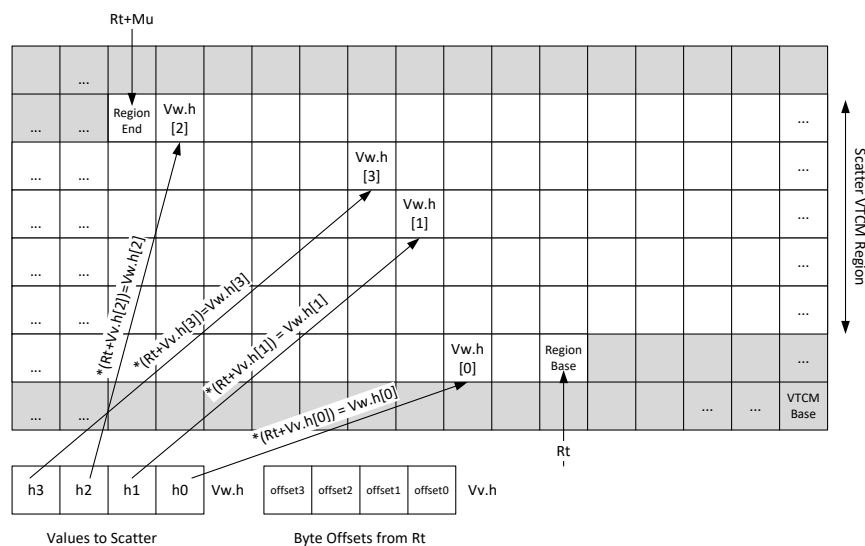
Rt – Scalar Indicating base address in VTCM

Vv – Vector with byte offsets from base

Mu – Scalar indicating length-1 of Region

Vw – Vector with halfword elements to be scattered

Example of vscatter (only first 4 elements shown)



Syntax	Behavior
<pre>if (Qs4) vscatter (Rt, Mu, Vv.h) .h=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(16); i++) { EA = Rt+Vv.uh[i]; if ((Rt <= EA <= Rt + MuV) & QsV) *EA = VwV.uh[i]; }</pre>
<pre>if (Qs4) vscatter (Rt, Mu, Vv.h)=Vw32.h</pre>	Assembler mapped to: "if (Qs4) vscatter (Rt, Mu2, Vv.h) .h=Vw32"
<pre>if (Qs4) vscatter (Rt, Mu, Vv.w) .w=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { EA = Rt+Vv.uw[i]; if ((Rt <= EA <= Rt + MuV) & QsV) *EA = VwV.uw[i]; }</pre>
<pre>if (Qs4) vscatter (Rt, Mu, Vv.w)=Vw32.w</pre>	Assembler mapped to: "if (Qs4) vscatter (Rt, Mu2, Vv.w) .w=Vw32"
<pre>vscatter (Rt, Mu, Vv.h) +=Vw32.h</pre>	Assembler mapped to: "vscatter (Rt, Mu2, Vv.h) .h+=Vw32"
<pre>vscatter (Rt, Mu, Vv.h) .h+=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(16); i++) { EA = (Rt+Vv.uh[i] = Vv.uh[i] & ~(ALIGNMENT- 1)); if (Rt <= EA <= Rt + MuV) *EA += VwV.uh[i]; }</pre>
<pre>vscatter (Rt, Mu, Vv.h) .h=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(16); i++) { EA = Rt+Vv.uh[i]; if (Rt <= EA <= Rt + MuV) *EA = VwV.uh[i]; }</pre>
<pre>vscatter (Rt, Mu, Vv.h)=Vw32.h</pre>	Assembler mapped to: "vscatter (Rt, Mu2, Vv.h) .h=Vw32"
<pre>vscatter (Rt, Mu, Vv.w) +=Vw32.w</pre>	Assembler mapped to: "vscatter (Rt, Mu2, Vv.w) .w+=Vw32"
<pre>vscatter (Rt, Mu, Vv.w) .w+=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { EA = (Rt+Vv.uw[i] = Vv.uw[i] & ~(ALIGNMENT- 1)); if (Rt <= EA <= Rt + MuV) *EA += VwV.uw[i]; }</pre>
<pre>vscatter (Rt, Mu, Vv.w) .w=Vw32</pre>	<pre>MuV = MuV (element_size-1); Rt = Rt & ~(element_size-1); for (i = 0; i < VELEM(32); i++) { EA = Rt+Vv.uw[i]; if (Rt <= EA <= Rt + MuV) *EA = VwV.uw[i]; }</pre>
<pre>vscatter (Rt, Mu, Vv.w)=Vw32.w</pre>	Assembler mapped to: "vscatter (Rt, Mu2, Vv.w) .w=Vw32"

Class: COPROC_VMEM (slots 0)**Notes**

- This instruction can use any HVX resource.

Intrinsics

if (Qs4) vscatter(Rt, Mu, Vv.h) .h=Vw32	void Q6_vscatter_QRMVhV(HVX_VectorPred Qs, HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv, HVX_Vector Vw)
if (Qs4) vscatter(Rt, Mu, Vv.w) .w=Vw32	void Q6_vscatter_QRMVwV(HVX_VectorPred Qs, HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv, HVX_Vector Vw)
vscatter(Rt, Mu, Vv.h) .h+=Vw32	void Q6_vscatteracc_RMVhV(HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv, HVX_Vector Vw)
vscatter(Rt, Mu, Vv.h) .h=Vw32	void Q6_vscatter_RMVhV(HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv, HVX_Vector Vw)
vscatter(Rt, Mu, Vv.w) .w+=Vw32	void Q6_vscatteracc_RMVwV(HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv, HVX_Vector Vw)
vscatter(Rt, Mu, Vv.w) .w=Vw32	void Q6_vscatter_RMVwV(HVX_Vector* Rb, Word32 Mu, HVX_Vector Vv, HVX_Vector Vw)

Encoding

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	
ICLASS								NT		t5				Parse		u1																
0	0	1	0	1	1	1	1	0	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	0	0	0	w	w	w	w	w	vscatter(Rt, Mu, Vv.w).w=Vw32
0	0	1	0	1	1	1	1	0	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	0	0	1	w	w	w	w	w	vscatter(Rt, Mu, Vv.h).h=Vw32
0	0	1	0	1	1	1	1	0	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	1	0	0	w	w	w	w	w	vscatter(Rt, Mu, Vv.w).w+=Vw32
0	0	1	0	1	1	1	1	0	0	1	t	t	t	t	t	P	P	u	v	v	v	v	v	1	0	1	w	w	w	w	w	vscatter(Rt, Mu, Vv.h).h+=Vw32
ICLASS								NT		t5				Parse		u1		s2														
0	0	1	0	1	1	1	1	1	0	0	t	t	t	t	t	P	P	u	v	v	v	v	v	0	s	s	w	w	w	w	w	if (Qs4) vscatter(Rt, Mu, Vv.w).w=Vw32
0	0	1	0	1	1	1	1	1	0	0	t	t	t	t	t	P	P	u	v	v	v	v	v	1	s	s	w	w	w	w	w	if (Qs4) vscatter(Rt, Mu, Vv.h).h=Vw32

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s2	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v5	Field to encode register v

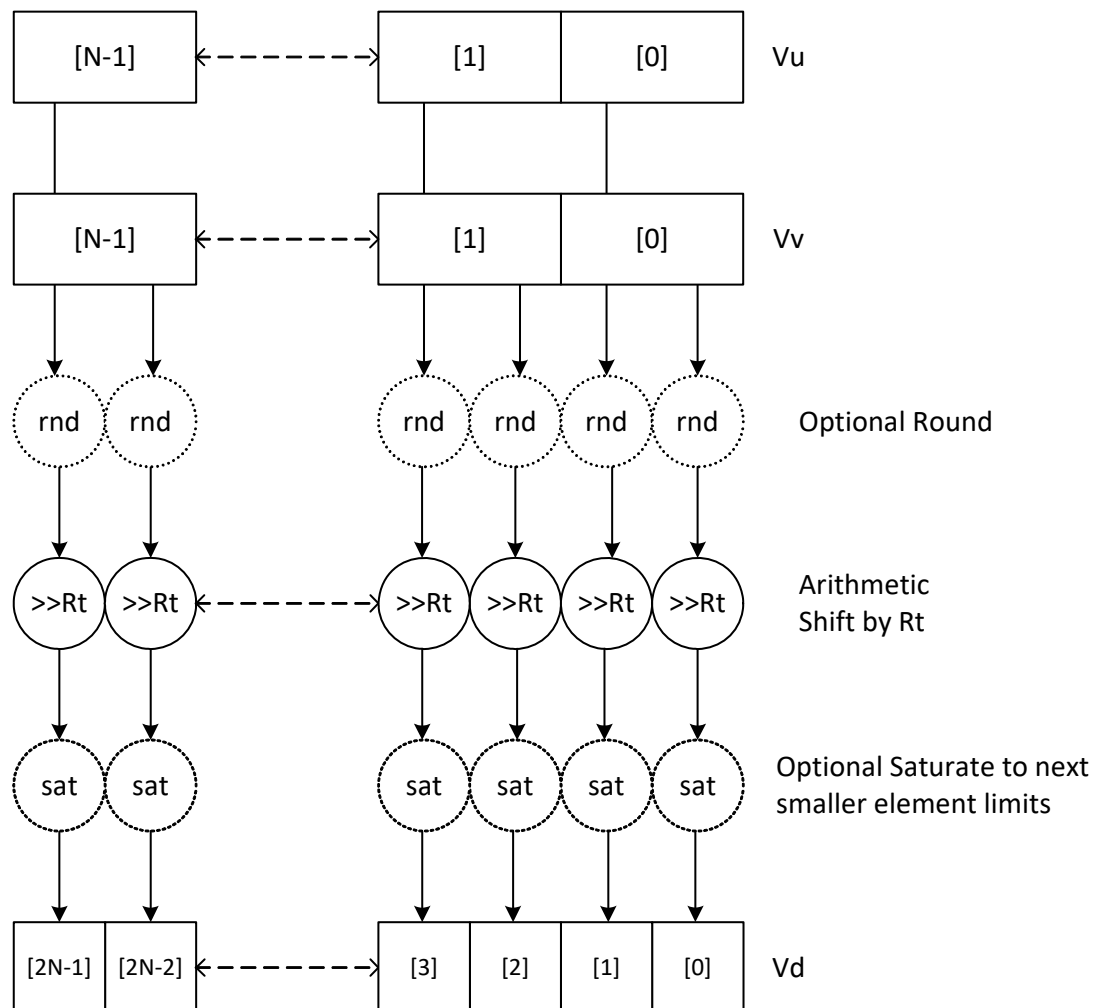
6.14 HVX/SHIFT-RESOURCE

The HVX/SHIFT-RESOURCE instruction subclass includes instructions that use the HVX shift resource.

Narrowing shift

Arithmetically shift-right the elements in vector registers V_u and V_v by the lower bits of the scalar register R_t . Each result is optionally saturated, rounded to infinity, and packed into a single destination vector register. Each even element in the destination vector register V_d comes from the vector register V_v , and each odd element in V_d comes from the vector register V_u .

$$V_d.h = \text{vasr}(V_u.w, V_v.w, R_t)[:\text{rnd}][:\text{sat}]$$



Syntax	Behavior
<code>Vd.b=vasr(Vu.h,Vv.h,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { shamt = Rt & 0x7; Vd.h[i].b[0]=sat_8(Vv.h[i] + (1<<(shamt-1)) >> shamt); Vd.h[i].b[1]=sat_8(Vu.h[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.h=vasr(Vu.w,Vv.w,Rt):rnd:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.w[i].h[0]=sat_16(Vv.w[i] + (1<<(shamt-1)) >> shamt); Vd.w[i].h[1]=sat_16(Vu.w[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.h=vasr(Vu.w,Vv.w,Rt)[:sat]</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.w[i].h[0]=[sat_16](Vv.w[i] >> shamt); Vd.w[i].h[1]=[sat_16](Vu.w[i] >> shamt) ; }</pre>
<code>Vd.ub=vasr(Vu.h,Vv.h,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { shamt = Rt & 0x7; Vd.h[i].b[0]=usat_8(Vv.h[i] + (1<<(shamt-1)) >> shamt); Vd.h[i].b[1]=usat_8(Vu.h[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.ub=vasr(Vu.uh,Vv.uh,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { shamt = Rt & 0x7; Vd.uh[i].b[0]=usat_8(Vv.uh[i] + (1<<(shamt-1)) >> shamt); Vd.uh[i].b[1]=usat_8(Vu.uh[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.uh=vasr(Vu.uw,Vv.uw,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.uw[i].h[0]=usat_16(Vv.uw[i] + (1<<(shamt-1)) >> shamt); Vd.uw[i].h[1]=usat_16(Vu.uw[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.uh=vasr(Vu.w,Vv.w,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.w[i].h[0]=usat_16(Vv.w[i] + (1<<(shamt-1)) >> shamt); Vd.w[i].h[1]=usat_16(Vu.w[i] + (1<<(shamt-1)) >> shamt) ; }</pre>

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- Input scalar register Rt is limited to registers 0 through 7
- This instruction uses the HVX shift resource.

Intrinsics

Vd.b=vasr(Vu.h,Vv.h,Rt) :rnd:sat	HVX_Vector Q6_Vb_vasr_VhVhR_rnd_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.b=vasr(Vu.h,Vv.h,Rt) :sat	HVX_Vector Q6_Vb_vasr_VhVhR_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vasr(Vu.w,Vv.w,Rt)	HVX_Vector Q6_Vh_vasr_VwVwR (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vasr(Vu.w,Vv.w,Rt) :rnd:sat	HVX_Vector Q6_Vh_vasr_VwVwR_rnd_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vasr(Vu.w,Vv.w,Rt) :sat	HVX_Vector Q6_Vh_vasr_VwVwR_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.h,Vv.h,Rt) :rnd:sat	HVX_Vector Q6_Vub_vasr_VhVhR_rnd_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.h,Vv.h,Rt) :sat	HVX_Vector Q6_Vub_vasr_VhVhR_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.uh,Vv.uh,Rt) :rnd:sat	HVX_Vector Q6_Vub_vasr_VuhVuhR_rnd_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.uh,Vv.uh,Rt) :sat	HVX_Vector Q6_Vub_vasr_VuhVuhR_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.uw,Vv.uw,Rt) :rnd:sat	HVX_Vector Q6_Vuh_vasr_VuwVuwR_rnd_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.uw,Vv.uw,Rt) :sat	HVX_Vector Q6_Vuh_vasr_VuwVuwR_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.w,Vv.w,Rt) :rnd:sat	HVX_Vector Q6_Vuh_vasr_VwVwR_rnd_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.w,Vv.w,Rt) :sat	HVX_Vector Q6_Vuh_vasr_VwVwR_sat (HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)

Encoding

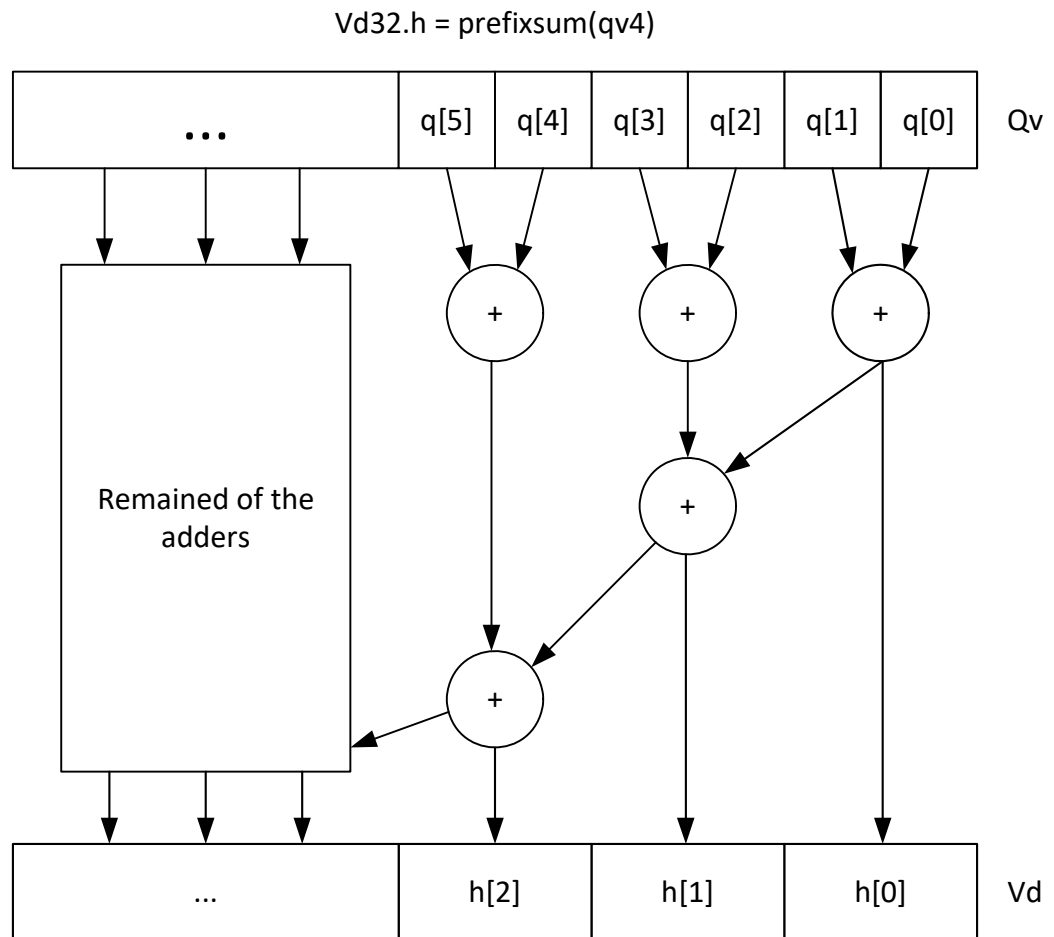
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																t3		Parse		u5					d5							
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vasr(Vu.h,Vv.h,Rt):sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.uh=vasr(Vu.uw,Vv.uw,Rt):rnd:sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uh=vasr(Vu.w,Vv.w,Rt):rnd:sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.ub=vasr(Vu.uh,Vv.uh,Rt):rnd:sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.uh=vasr(Vu.uw,Vv.uw,Rt):sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.ub=vasr(Vu.uh,Vv.uh,Rt):sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.h=vasr(Vu.w,Vv.w,Rt)
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vasr(Vu.w,Vv.w,Rt):sat

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	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.h=vasr(Vu.w,Vv.w,Rt):rnd:sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.uh=vasr(Vu.w,Vv.w,Rt):sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.ub=vasr(Vu.h,Vv.h,Rt):sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.ub=vasr(Vu.h,Vv.h,Rt):rnd:sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vasr(Vu.h,Vv.h,Rt):rnd:sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t3	Field to encode register t
u5	Field to encode register u
v2	Field to encode register v
v3	Field to encode register v

Compute contiguous offsets for valid positions

Perform a cumulative sum of the bits in the predicate register.



Syntax

`Vd.b=prefixsum(Qv4)`

`Vd.h=prefixsum(Qv4)`

`Vd.w=prefixsum(Qv4)`

Behavior

```
for (i = 0; i < VELEM(8); i++) {
  acc += QvV[i];
  Vd.ub[i] = acc;
}
```

```
for (i = 0; i < VELEM(16); i++) {
  acc += QvV[i*2+0];
  acc += QvV[i*2+1];
  Vd.uh[i] = acc;
}
```

```
for (i = 0; i < VELEM(32); i++) {
  acc += QvV[i*4+0];
  acc += QvV[i*4+1];
  acc += QvV[i*4+2];
  acc += QvV[i*4+3];
  Vd.uw[i] = acc;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX shift resource.

Intrinsics

Vd.b=prefixsum(Qv4)

HVX_Vector Q6_Vb_prefixsum_Q(HVX_VectorPred Qv)

Vd.h=prefixsum(Qv4)

HVX_Vector Q6_Vh_prefixsum_Q(HVX_VectorPred Qv)

Vd.w=prefixsum(Qv4)

HVX_Vector Q6_Vw_prefixsum_Q(HVX_VectorPred Qv)

Encoding

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	
ICLASS																Parse								d5								
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	1	P	P	1	-	-	0	0	0	0	1	0	d	d	d	d	d	Vd.b=prefixsum(Qv4)
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	1	P	P	1	-	-	0	0	1	0	1	0	d	d	d	d	d	Vd.h=prefixsum(Qv4)
0	0	0	1	1	1	1	0	v	v	0	-	-	0	1	1	P	P	1	-	-	0	1	0	0	1	0	d	d	d	d	d	Vd.w=prefixsum(Qv4)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
v2	Field to encode register v

Add - half precision vector by vector

Half precision (16-bit) add.

Syntax

```
Vd.qf16=vadd(Vu.hf,Vv.hf)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    u = Vu.hf[i];
    v = Vv.hf[i];
    if (u.exp>v.exp) {
        exp = u.exp+((u.sig==0.0)? (-
(FRAC_HF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+((v.sig==0.0)? (-
(FRAC_HF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    if((u.sign^v.sign)==0){
        sig = sig_u + sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-
sig)+sig_v : (sig_v-sig)+sig_u;
    } else if((u.sign==0) && (v.sign==1)) {
        sig = sig_u - sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-sig)-
sig_v : sig_u-(sig_v+sig);
    } else{
        sig = sig_v - sig_u;
        sig_low = (v.exp>u.exp) ? (sig_v-sig)-
sig_u : sig_v-(sig_u+sig);
    }
    Vd.qf16[i] = rnd_sat(exp,sig,sig_low);
    if(u.sign && v.sign) Vd.qf16[i] = -
(Vd.qf16[i]);
}
```

```
Vd.qf16=vadd(Vu.qf16,Vv.hf)
```

```
for (i = 0; i < VELEM(16); i++) {
    u = Vu.qf16[i];
    v = Vv.hf[i];
    if(v.sign) v.sig = (-1.0)*v.sig;
    if (u.exp>v.exp) {
        exp = u.exp+((u.sig==0.0)? (-
(FRAC_HF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+((v.sig==0.0)? (-
(FRAC_HF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u + sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)+sig_v
: (sig_v-sig)+sig_u;
    Vd.qf16[i] = rnd_sat(exp,sig,sig_low);
}
```

Syntax

```
Vd.qf16=vadd(Vu.qf16,Vv.qf16)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    u = Vu.qf16[i];
    v = Vv.qf16[i];
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_HF+1)):ilogb(u.sig);
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_HF+1)):ilogb(v.sig);
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u + sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)+sig_v
: (sig_v-sig)+sig_u;
    Vd.qf16[i] = rnd_sat(exp,sig,sig_low);
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX shift resource.

Intrinsics

```
Vd.qf16=vadd(Vu.hf,Vv.hf)
```

```
HVX_Vector Q6_Vqf16_vadd_VhfVhf(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf16=vadd(Vu.qf16,Vv.hf)
```

```
HVX_Vector Q6_Vqf16_vadd_Vqf16Vhf(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf16=vadd(Vu.qf16,Vv.qf16)
```

```
HVX_Vector Q6_Vqf16_vadd_Vqf16Vqf16(HVX_Vector
Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.qf16=vadd(Vu.qf16,Vv.qf16)
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.qf16=vadd(Vu.hf,Vv.hf)
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.qf16=vadd(Vu.qf16,Vv.hf)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Add - single precision vector by vector

Single precision (32-bit) add.

Syntax

```
Vd.qf32=vadd(Vu.qf32,Vv.qf32)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.qf32[i];
    v = Vv.qf32[i];
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_SF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_SF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u + sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)+sig_v
: (sig_v-sig)+sig_u;
    Vd.qf32[i] = rnd_sat(exp,sig,sig_low);
}
```

```
Vd.qf32=vadd(Vu.qf32,Vv.sf)
```

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.qf32[i];
    v = Vv.sf[i];
    if(v.sign) v.sig = (-1.0)*v.sig;
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_SF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_SF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u + sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)+sig_v
: (sig_v-sig)+sig_u;
    Vd.qf32[i] = rnd_sat(exp,sig,sig_low);
}
```


Syntax

```
Vd.qf32=vadd(Vu.sf,Vv.sf)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.sf[i];
    v = Vv.sf[i];
    if (u.exp>v.exp) {
        exp = u.exp+((u.sig==0.0)? (-
(FRAC_SF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+((v.sig==0.0)? (-
(FRAC_SF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    if((u.sign^v.sign)==0){
        sig = sig_u + sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-
sig)+sig_v : (sig_v-sig)+sig_u;
    } else if((u.sign==0) && (v.sign==1)) {
        sig = sig_u - sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-sig)-
sig_v : sig_u-(sig_v+sig);
    } else{
        sig = sig_v - sig_u;
        sig_low = (v.exp>u.exp) ? (sig_v-sig)-
sig_u : sig_v-(sig_u+sig);
    }
    Vd.qf32[i] = rnd_sat(exp,sig,sig_low);
    if(u.sign && v.sign) Vd.qf32[i] = -
(Vd.qf32[i]) ;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX shift resource.

Intrinsics

```
Vd.qf32=vadd(Vu.qf32,Vv.qf32)
```

```
HVX_Vector Q6_Vqf32_vadd_Vqf32Vqf32 (HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vd.qf32=vadd(Vu.qf32,Vv.sf)
```

```
HVX_Vector Q6_Vqf32_vadd_Vqf32Vsf (HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf32=vadd(Vu.sf,Vv.sf)
```

```
HVX_Vector Q6_Vqf32_vadd_VsfVsf (HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

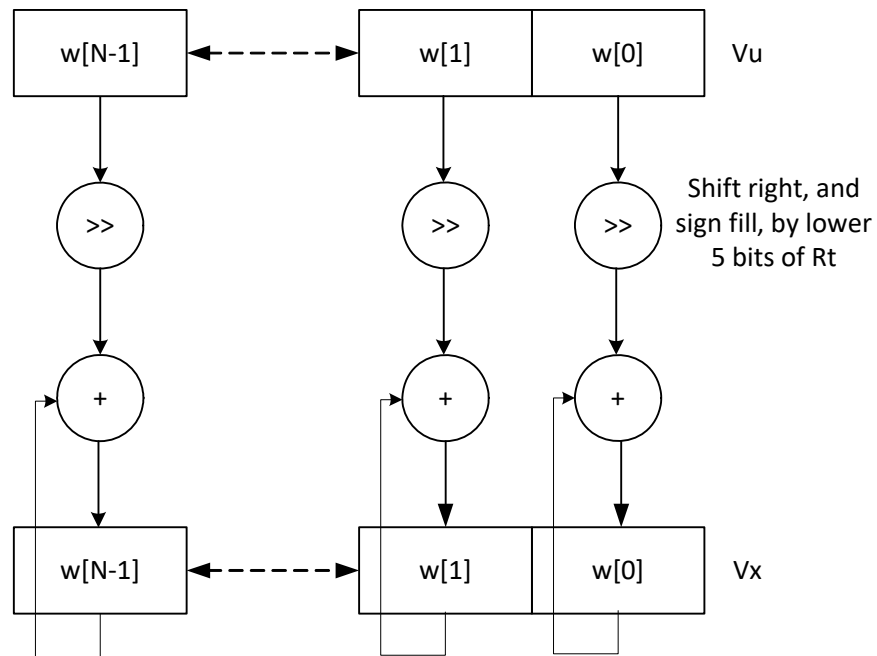
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.qf32=vadd(Vu.qf32,Vv.qf32)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.qf32=vadd(Vu.sf,Vv.sf)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.qf32=vadd(Vu.qf32,Vv.sf)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

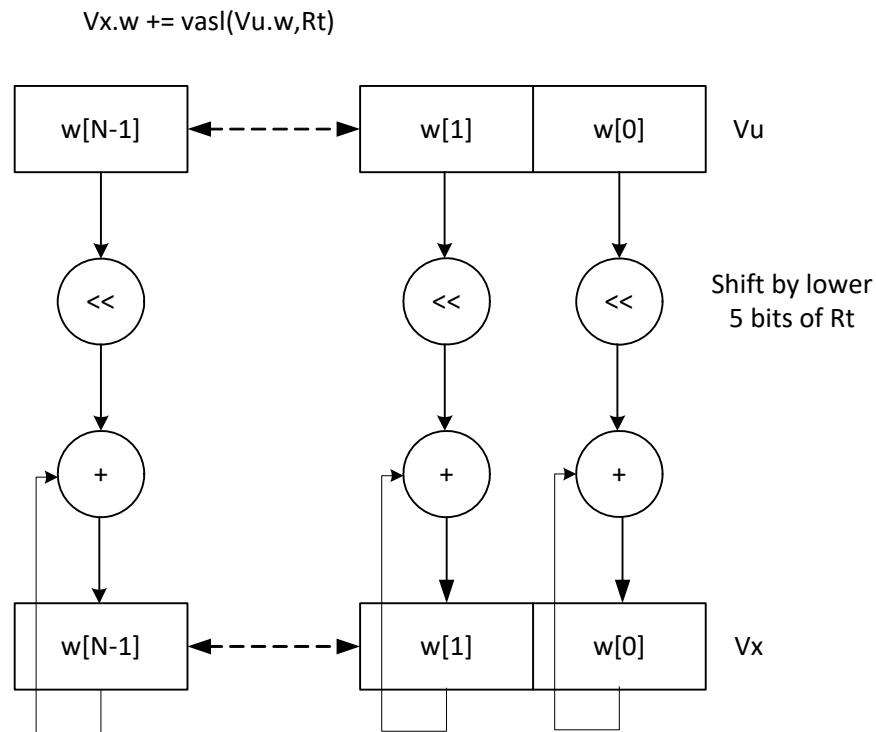
Shift and add

Each element in the vector register V_u is arithmetically shifted right by the value specified by the lower bits of the scalar register R_t . The result is then added to the destination vector register V_x . For signed word shifts the lower five bits of R_t specify the shift amount. The left shift does not saturate the result to the element size.

$V_x.w += \text{vasr}(V_u.w, R_t)$



*N is the number of operations implemented in each vector



*N is the number of operations implemented in each vector

Syntax	Behavior
$Vx.h += vasl(Vu.h, Rt)$	<pre>for (i = 0; i < VELEM(16); i++) { Vx.h[i] += (Vu.h[i] << (Rt & (16-1))) ; }</pre>
$Vx.h += vasr(Vu.h, Rt)$	<pre>for (i = 0; i < VELEM(16); i++) { Vx.h[i] += (Vu.h[i] >> (Rt & (16-1))) ; }</pre>
$Vx.w += vasl(Vu.w, Rt)$	<pre>for (i = 0; i < VELEM(32); i++) { Vx.w[i] += (Vu.w[i] << (Rt & (32-1))) ; }</pre>
$Vx.w += vasr(Vu.w, Rt)$	<pre>for (i = 0; i < VELEM(32); i++) { Vx.w[i] += (Vu.w[i] >> (Rt & (32-1))) ; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX shift resource.

Intrinsics

<code>Vx.h+=vasl(Vu.h,Rt)</code>	HVX_Vector Q6_Vh_vaslacc_VhVhR (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
<code>Vx.h+=vasr(Vu.h,Rt)</code>	HVX_Vector Q6_Vh_vasracc_VhVhR (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
<code>Vx.w+=vasl(Vu.w,Rt)</code>	HVX_Vector Q6_Vw_vaslacc_VwVwR (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)
<code>Vx.w+=vasr(Vu.w,Rt)</code>	HVX_Vector Q6_Vw_vasracc_VwVwR (HVX_Vector Vx, HVX_Vector Vu, Word32 Rt)

Encoding

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	
ICLASS												t5					Parse		u5					x5								
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	u	u	u	u	u	0	1	0	x	x	x	x	x	Vx.w+=vasl(Vu.w,Rt)
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vx.w+=vasr(Vu.w,Rt)
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	1	u	u	u	u	u	1	1	1	x	x	x	x	x	Vx.h+=vasr(Vu.h,Rt)
0	0	0	1	1	0	0	1	1	0	1	t	t	t	t	t	P	P	1	u	u	u	u	u	1	0	1	x	x	x	x	x	Vx.h+=vasl(Vu.h,Rt)

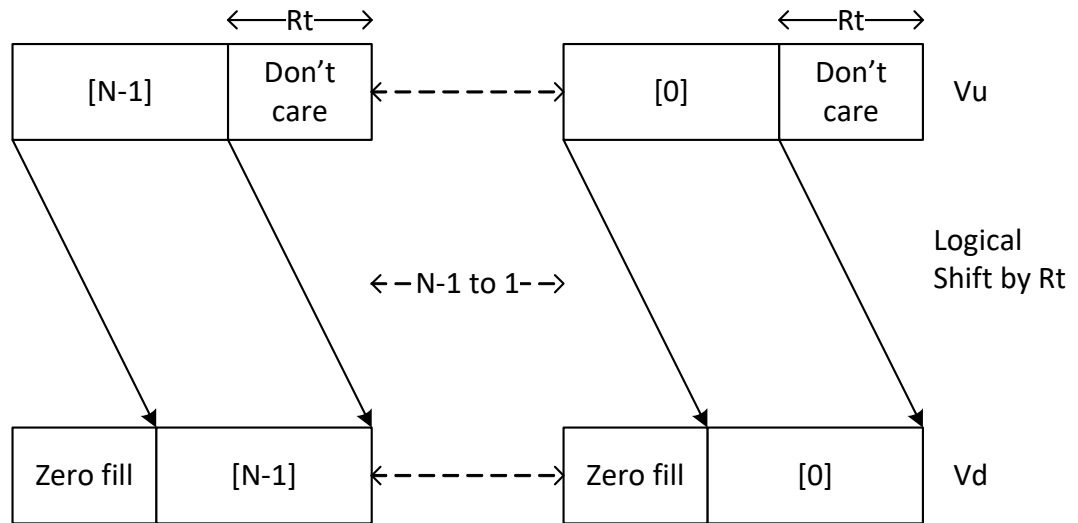
Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
t5	Field to encode register t
u5	Field to encode register u
x5	Field to encode register x

Shift

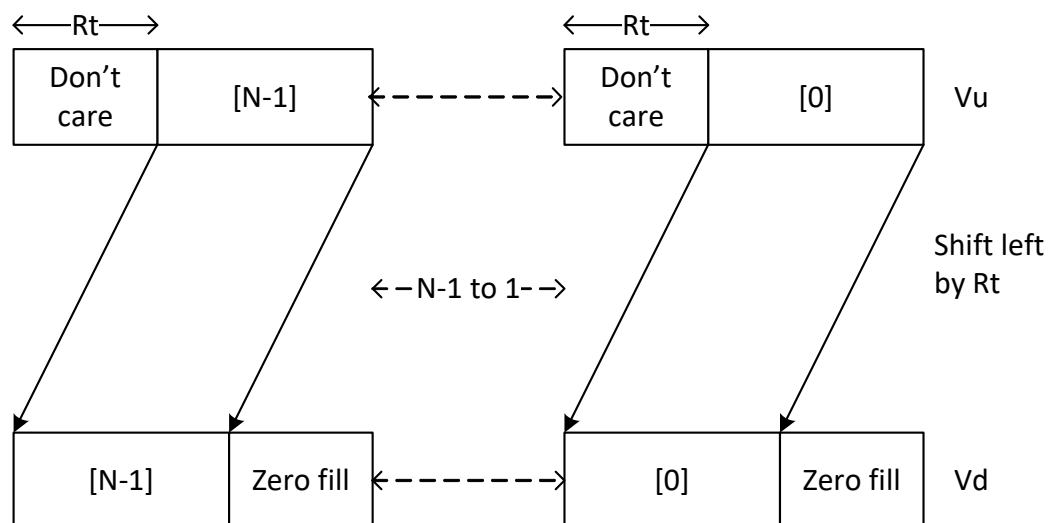
Each element in the vector register V_u is arithmetically (logically) shifted right (left) by the value specified in the lower bits of the corresponding element of vector register V_v (or scalar register R_t). For halfword shifts the lower 4 bits are used, while for word shifts the lower 5 bits are used.

The logical left shift does not saturate the result to the element size.

$V_d.w = vlsr(V_u.w, R_t)$



$V_d.w = vasl(V_u.w, R_t)$



Syntax	Behavior
<code>Vd.b=vasr(Vu.h,Vv.h,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { shamt = Rt & 0x7; Vd.h[i].b[0]=sat_8(Vv.h[i] + (1<<(shamt-1)) >> shamt); Vd.h[i].b[1]=sat_8(Vu.h[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.h=vasl(Vu.h,Rt)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.h[i] = (Vu.h[i] << (Rt & (16-1))) ; }</pre>
<code>Vd.h=vasl(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.h[i] = (sxt₍₄₊₁₎- >16(Vv.h[i])>0)?(Vu.h[i]<<sxt₍₄₊₁₎- >16(Vv.h[i])):(Vu.h[i]>>sxt₍₄₊₁₎->16(Vv.h[i])) ; }</pre>
<code>Vd.h=vasr(Vu.h,Rt)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.h[i] = (Vu.h[i] >> (Rt & (16-1))) ; }</pre>
<code>Vd.h=vasr(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.h[i] = (sxt₍₄₊₁₎- >16(Vv.h[i])>0)?(Vu.h[i]>>sxt₍₄₊₁₎- >16(Vv.h[i])):(Vu.h[i]<<sxt₍₄₊₁₎->16(Vv.h[i])) ; }</pre>
<code>Vd.h=vasr(Vu.w,Vv.w,Rt):rnd:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.w[i].h[0]=sat_16(Vv.w[i] + (1<<(shamt-1)) >> shamt); Vd.w[i].h[1]=sat_16(Vu.w[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.h=vasr(Vu.w,Vv.w,Rt):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.w[i].h[0]=[sat_16](Vv.w[i] >> shamt); Vd.w[i].h[1]=[sat_16](Vu.w[i] >> shamt) ; }</pre>
<code>Vd.h=vlsr(Vu.h,Vv.h)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = (sxt₍₄₊₁₎- >16(Vv.h[i])>0)?(Vu.uh[i]>>>sxt₍₄₊₁₎- >16(Vv.h[i])):(Vu.uh[i]<<sxt₍₄₊₁₎->16(Vv.h[i])) ; }</pre>
<code>Vd.ub=vasr(Vu.h,Vv.h,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { shamt = Rt & 0x7; Vd.h[i].b[0]=usat_8(Vv.h[i] + (1<<(shamt-1)) >> shamt); Vd.h[i].b[1]=usat_8(Vu.h[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.ub=vasr(Vu.uh,Vv.uh,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { shamt = Rt & 0x7; Vd.uh[i].b[0]=usat_8(Vv.uh[i] + (1<<(shamt- 1)) >> shamt); Vd.uh[i].b[1]=usat_8(Vu.uh[i] + (1<<(shamt- 1)) >> shamt) ; }</pre>

Syntax	Behavior
<code>Vd.ub=vlsr(Vu.ub,Rt)</code>	<pre>for (i = 0; i < VELEM(8); i++) { Vd.b[i] = Vu.ub[i] >> (Rt & 0x7) ; }</pre>
<code>Vd.uh=vasr(Vu.uw,Vv.uw,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.uw[i].h[0]=usat_16(Vv.uw[i] + (1<<(shamt-1)) >> shamt); Vd.uw[i].h[1]=usat_16(Vu.uw[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.uh=vasr(Vu.w,Vv.w,Rt)[:rnd]:sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { shamt = Rt & 0xF; Vd.w[i].h[0]=usat_16(Vv.w[i] + (1<<(shamt-1)) >> shamt); Vd.w[i].h[1]=usat_16(Vu.w[i] + (1<<(shamt-1)) >> shamt) ; }</pre>
<code>Vd.uh=vlsr(Vu.uh,Rt)</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i] = (Vu.uh[i] >> (Rt & (16-1))) ; }</pre>
<code>Vd.uw=vlsr(Vu.uw,Rt)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i] = (Vu.uw[i] >> (Rt & (32-1))) ; }</pre>
<code>Vd.w=vasl(Vu.w,Rt)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i] << (Rt & (32-1))) ; }</pre>
<code>Vd.w=vasl(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (sxt₍₅₊₁₎->32(Vv.w[i])>0)?(Vu.w[i]<<sxt₍₅₊₁₎->32(Vv.w[i])):(Vu.w[i]>>sxt₍₅₊₁₎->32(Vv.w[i])) ; }</pre>
<code>Vd.w=vasr(Vu.w,Rt)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (Vu.w[i] >> (Rt & (32-1))) ; }</pre>
<code>Vd.w=vasr(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = (sxt₍₅₊₁₎->32(Vv.w[i])>0)?(Vu.w[i]>>sxt₍₅₊₁₎->32(Vv.w[i])):(Vu.w[i]<<sxt₍₅₊₁₎->32(Vv.w[i])) ; }</pre>
<code>Vd.w=vlsr(Vu.w,Vv.w)</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i] = (sxt₍₅₊₁₎->32(Vv.w[i])>0)?(Vu.uw[i]>>sxt₍₅₊₁₎->32(Vv.w[i])):(Vu.uw[i]<<sxt₍₅₊₁₎->32(Vv.w[i])) ; }</pre>

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- Input scalar register Rt is limited to registers 0 through 7
- This instruction uses the HVX shift resource.

Intrinsics

Vd.b=vasr(Vu.h,Vv.h,Rt) :rnd:sat	HVX_Vector Q6_Vb_vasr_VhVhR_rnd_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.b=vasr(Vu.h,Vv.h,Rt) :sat	HVX_Vector Q6_Vb_vasr_VhVhR_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vasl(Vu.h,Rt)	HVX_Vector Q6_Vh_vasl_VhR(HVX_Vector Vu, Word32 Rt)
Vd.h=vasl(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vasl_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vasr(Vu.h,Rt)	HVX_Vector Q6_Vh_vasr_VhR(HVX_Vector Vu, Word32 Rt)
Vd.h=vasr(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vasr_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vasr(Vu.w,Vv.w,Rt)	HVX_Vector Q6_Vh_vasr_VwVwR(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vasr(Vu.w,Vv.w,Rt) :rnd:sat	HVX_Vector Q6_Vh_vasr_VwVwR_rnd_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vasr(Vu.w,Vv.w,Rt) :sat	HVX_Vector Q6_Vh_vasr_VwVwR_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.h=vlsr(Vu.h,Vv.h)	HVX_Vector Q6_Vh_vlsr_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.ub=vasr(Vu.h,Vv.h,Rt) :rnd:sat	HVX_Vector Q6_Vub_vasr_VhVhR_rnd_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.h,Vv.h,Rt) :sat	HVX_Vector Q6_Vub_vasr_VhVhR_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.uh,Vv.uh,Rt) :rnd:sat	HVX_Vector Q6_Vub_vasr_VuhVuhR_rnd_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vasr(Vu.uh,Vv.uh,Rt) :sat	HVX_Vector Q6_Vub_vasr_VuhVuhR_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.ub=vlsr(Vu.ub,Rt)	HVX_Vector Q6_Vub_vlsr_VubR(HVX_Vector Vu, Word32 Rt)
Vd.uh=vasr(Vu.uw,Vv.uw,Rt) :rnd:sat	HVX_Vector Q6_Vuh_vasr_VuwVuwR_rnd_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.uw,Vv.uw,Rt) :sat	HVX_Vector Q6_Vuh_vasr_VuwVuwR_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.w,Vv.w,Rt) :rnd:sat	HVX_Vector Q6_Vuh_vasr_VwVwR_rnd_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vasr(Vu.w,Vv.w,Rt) :sat	HVX_Vector Q6_Vuh_vasr_VwVwR_sat(HVX_Vector Vu, HVX_Vector Vv, Word32 Rt)
Vd.uh=vlsr(Vu.uh,Rt)	HVX_Vector Q6_Vuh_vlsr_VuhR(HVX_Vector Vu, Word32 Rt)
Vd.uw=vlsr(Vu.uw,Rt)	HVX_Vector Q6_Vuw_vlsr_VuwR(HVX_Vector Vu, Word32 Rt)

Vd.w=vasl(Vu.w,Rt)	HVX_Vector Q6_Vw_vasl_VwR(HVX_Vector Vu, Word32 Rt)
Vd.w=vasl(Vu.w,Vv.w)	HVX_Vector Q6_Vw_vasl_VwVw(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vasr(Vu.w,Rt)	HVX_Vector Q6_Vw_vasr_VwR(HVX_Vector Vu, Word32 Rt)
Vd.w=vasr(Vu.w,Vv.w)	HVX_Vector Q6_Vw_vasr_VwVw(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vlsr(Vu.w,Vv.w)	HVX_Vector Q6_Vw_vlsr_VwVw(HVX_Vector Vu, HVX_Vector Vv)

Encoding

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	
ICLASS																t3		Parse		u5					d5							
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vasr(Vu.h,Vv.h,Rt):sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.uh=vasr(Vu.uw,Vv.uw,Rt):rnd:sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uh=vasr(Vu.w,Vv.w,Rt):rnd:sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.ub=vasr(Vu.uh,Vv.uh,Rt):rnd:sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.uh=vasr(Vu.uw,Vv.uw,Rt):sat
0	0	0	1	1	0	0	0	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.ub=vasr(Vu.uh,Vv.uh,Rt):sat
ICLASS																t5		Parse		u5					d5							
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.w=vasr(Vu.w,Rt)
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.h=vasr(Vu.h,Rt)
0	0	0	1	1	0	0	1	0	1	1	t	t	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.w=vasl(Vu.w,Rt)
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.h=vasl(Vu.h,Rt)
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.uw=vlsr(Vu.uw,Rt)
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.uh=vlsr(Vu.uh,Rt)
0	0	0	1	1	0	0	1	1	0	0	t	t	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.ub=vlsr(Vu.ub,Rt)
ICLASS																t3		Parse		u5					d5							
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.h=vasr(Vu.w,Vv.w,Rt)
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vasr(Vu.w,Vv.w,Rt):sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.h=vasr(Vu.w,Vv.w,Rt):rnd:sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.uh=vasr(Vu.w,Vv.w,Rt):sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.ub=vasr(Vu.h,Vv.h,Rt):sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.ub=vasr(Vu.h,Vv.h,Rt):rnd:sat
0	0	0	1	1	0	1	1	v	v	v	v	v	t	t	t	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.b=vasr(Vu.h,Vv.h,Rt):rnd:sat
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.w=vasr(Vu.w,Vv.w)

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	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.w=vlsr(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	0	d	d	d	d	d	Vd.h=vlsr(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.h=vasr(Vu.h,Vv.h)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.w=vasl(Vu.w,Vv.w)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.h=vasl(Vu.h,Vv.h)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
t3	Field to encode register t
t5	Field to encode register t
u5	Field to encode register u
v2	Field to encode register v
v3	Field to encode register v
v5	Field to encode register v

Convert qfloat to IEEE floating point

Convert qfloat input vector register(s) to an IEEE output vector register.

Syntax	Behavior
Vd.hf=Vu.qf16	<pre>for (i = 0; i < VELEM(16); i++) { u = Vu.qf16[i]; Vd.hf[i] = rnd_sat(u.exp,u.sig) ; }</pre>
Vd.hf=Vuu.qf32	<pre>for (i = 0; i < VELEM(32); i++) { u0 = Vuu.v[0].qf32[i]; u1 = Vuu.v[1].qf32[i]; Vd.hf[2*i] = rnd_sat(u0.exp,u0.sig); Vd.hf[2*i+1] = rnd_sat(u1.exp,u1.sig) ; }</pre>
Vd.sf=Vu.qf32	<pre>for (i = 0; i < VELEM(32); i++) { u = Vu.qf32[i]; Vd.sf[i] = rnd_sat(u.exp,u.sig) ; }</pre>

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX shift resource.

Intrinsics

Vd.hf=Vu.qf16	HVX_Vector Q6_Vhf_equals_Vqf16 (HVX_Vector Vu)
Vd.hf=Vuu.qf32	HVX_Vector Q6_Vhf_equals_Wqf32 (HVX_VectorPair Vuu)
Vd.sf=Vu.qf32	HVX_Vector Q6_Vsf_equals_Vqf32 (HVX_Vector Vu)

Encoding

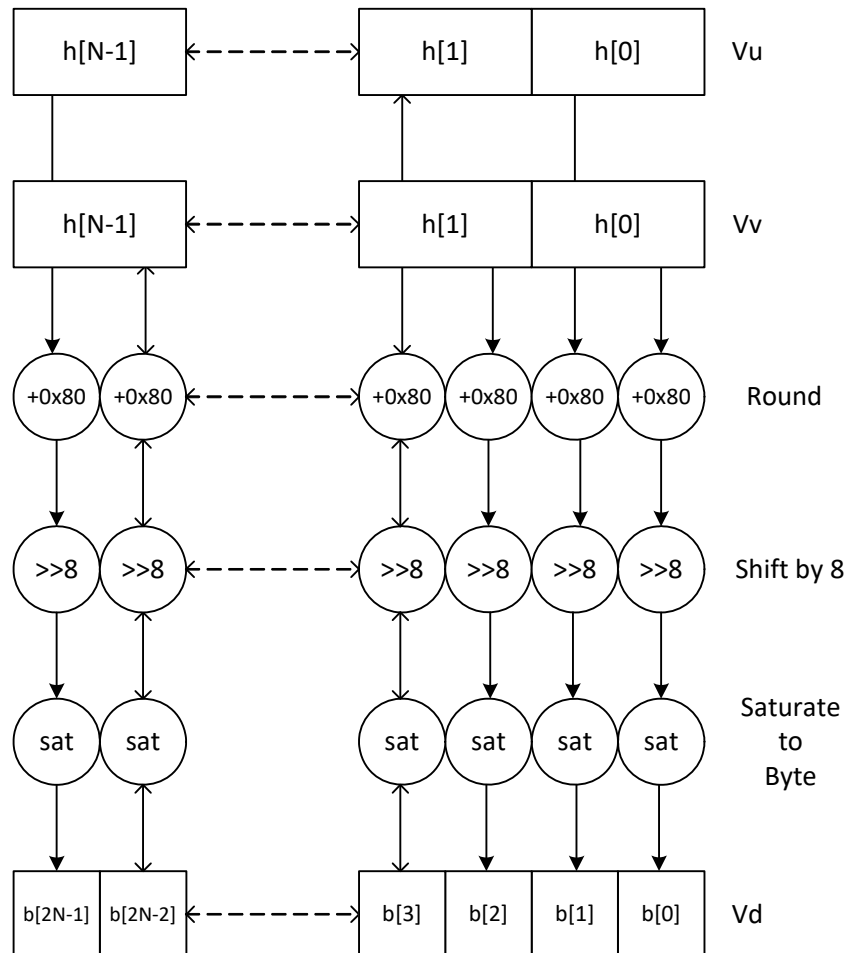
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	0	-	-	0	-	-	1	0	0	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.sf=Vu.qf32
0	0	0	1	1	1	1	0	-	-	0	-	-	1	0	0	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.hf=Vu.qf16
0	0	0	1	1	1	1	0	-	-	0	-	-	1	0	0	P	P	1	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.hf=Vuu.qf32

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u

Round to next smaller element size

Pack signed words to signed or unsigned halfwords, add 0x8000 to the lower 16 bits, logically or arithmetically right-shift by 16, and saturate the results to unsigned or signed halfwords respectively. Alternatively pack signed halfwords to signed or unsigned bytes, add 0x80 to the lower 8 bits, logically or arithmetically right-shift by 8, and saturate the results to unsigned or signed bytes respectively. The odd elements in the destination vector register Vd come from vector register Vv, and the even elements from Vu.

$Vd.b = \text{vround}(Vu.h, Vv.h) : \text{sat}$



Syntax

```
Vd.b=vround(Vu.h,Vv.h):sat
```

```
Vd.h=vround(Vu.w,Vv.w):sat
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    Vd.uh[i].b[0]=sat_8((Vv.h[i] + 0x80) >> 8);
    Vd.uh[i].b[1]=sat_8((Vu.h[i] + 0x80) >> 8);
}
```

```
for (i = 0; i < VELEM(32); i++) {
    Vd.uw[i].h[0]=sat_16((Vv.w[i] + 0x8000) >>
16);
    Vd.uw[i].h[1]=sat_16((Vu.w[i] + 0x8000) >>
16);
}
```

Syntax	Behavior
<code>Vd.ub=vround(Vu.h,Vv.h):sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i].b[0]=usat_8((Vv.h[i] + 0x80) >> 8); Vd.uh[i].b[1]=usat_8((Vu.h[i] + 0x80) >> 8); } ;</pre>
<code>Vd.ub=vround(Vu.uh,Vv.uh):sat</code>	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i].b[0]=usat_8((Vv.uh[i] + 0x80) >> 8); Vd.uh[i].b[1]=usat_8((Vu.uh[i] + 0x80) >> 8); } ;</pre>
<code>Vd.uh=vround(Vu.uw,Vv.uw):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i].h[0]=usat_16((Vv.uw[i] + 0x8000) >> 16); Vd.uw[i].h[1]=usat_16((Vu.uw[i] + 0x8000) >> 16); } ;</pre>
<code>Vd.uh=vround(Vu.w,Vv.w):sat</code>	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i].h[0]=usat_16((Vv.w[i] + 0x8000) >> 16); Vd.uw[i].h[1]=usat_16((Vu.w[i] + 0x8000) >> 16); } ;</pre>

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX shift resource.

Intrinsics

<code>Vd.b=vround(Vu.h,Vv.h):sat</code>	<code>HVX_Vector Q6_Vb_vround_VhVh_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.h=vround(Vu.w,Vv.w):sat</code>	<code>HVX_Vector Q6_Vh_vround_VwVw_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.ub=vround(Vu.h,Vv.h):sat</code>	<code>HVX_Vector Q6_Vub_vround_VhVh_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.ub=vround(Vu.uh,Vv.uh):sat</code>	<code>HVX_Vector Q6_Vub_vround_VuhVuh_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.uh=vround(Vu.uw,Vv.uw):sat</code>	<code>HVX_Vector Q6_Vuh_vround_VuwVuw_sat(HVX_Vector Vu, HVX_Vector Vv)</code>
<code>Vd.uh=vround(Vu.w,Vv.w):sat</code>	<code>HVX_Vector Q6_Vuh_vround_VwVw_sat(HVX_Vector Vu, HVX_Vector Vv)</code>

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.h=vround(Vu.w,Vv.w):sat
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.uh=vround(Vu.w,Vv.w):sat
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.b=vround(Vu.h,Vv.h):sat
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.ub=vround(Vu.h,Vv.h):sat
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.ub=vround(Vu.uh,Vv.uh):sat
0	0	0	1	1	1	1	1	1	1	1	v	v	v	v	v	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.uh=vround(Vu.uw,Vv.uw):sat

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Vector rotate right word

Rotate right each element of $Vu.w$ by the unsigned amount specified by bits 4:0 of corresponding element of $Vv.w$, place the result in respective elements of $Vd.w$.

Syntax

```
Vd.uw=vrotr(Vu.uw,Vv.uw)
```

```
Vd=vrotr(Vu,Vv)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    Vd.uw[i] = ((Vu.uw[i] >> (Vv.uw[i] & 0x1f))
| (Vu.uw[i] << (32 - (Vv.uw[i] & 0x1f)))) ;
}
```

Assembler mapped to: "Vd.uw=vrotr(Vu.uw,Vv.uw)"

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX shift resource.

Intrinsics

```
Vd.uw=vrotr(Vu.uw,Vv.uw)
```

```
HVX_Vector Q6_Vuw_vrotr_VuwVuw(HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

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	
ICLASS										Parse					u5					d5												
0	0	0	1	1	0	1	0	1	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.uw=vrotr(Vu.uw,Vv.uw)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Subtract - half precision vector by vector

Half precision (16-bit) subtract.

Syntax

```
Vd.qf16=vsub(Vu.hf,Vv.hf)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    u = Vu.hf[i];
    v = Vv.hf[i];
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_HF+1)):ilgob(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_HF+1)):ilgob(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    if((u.sign==0) && (v.sign==0)) {
        sig = sig_u - sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-sig) -
sig_v : (sig_u-(sig_v+sig));
    } else if(u.sign ^ v.sign){
        sig = sig_u + sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-
sig)+sig_v : (sig_v-sig)+sig_u;
    } else{
        sig = sig_v - sig_u;
        sig_low = (v.exp>u.exp) ? (sig_v-sig) -
sig_u : sig_v-(sig_u+sig);
    }
    Vd.qf16[i] = rnd_sat(exp,sig,sig_low);
    if((u.sign==1) && (v.sign==0)) Vd.qf16[i] =
-(Vd.qf16[i]) ;
}
```

```
Vd.qf16=vsub(Vu.qf16,Vv.hf)
```

```
for (i = 0; i < VELEM(16); i++) {
    u = Vu.qf16[i];
    v = Vv.hf[i];
    if(v.sign) v.sig = (-1.0)*v.sig;
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_HF+1)):ilgob(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_HF+1)):ilgob(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u - sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)-sig_v
: (sig_u-(sig_v+sig));
    Vd.qf16[i] = rnd_sat(exp,sig,sig_low) ;
}
```

Syntax

```
Vd.qf16=vsub(Vu.qf16,Vv.qf16)
```

Behavior

```
for (i = 0; i < VELEM(16); i++) {
    u = Vu.qf16[i];
    v = Vv.qf16[i];
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_HF+1)):ilogb(u.sig);
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_HF+1)):ilogb(v.sig);
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u - sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)-sig_v
: (sig_u-(sig_v+sig));
    Vd.qf16[i] = rnd_sat(exp,sig,sig_low) ;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX shift resource.

Intrinsics

```
Vd.qf16=vsub(Vu.hf,Vv.hf)
```

```
HVX_Vector Q6_Vqf16_vsub_VhfVhf(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf16=vsub(Vu.qf16,Vv.hf)
```

```
HVX_Vector Q6_Vqf16_vsub_Vqf16Vhf(HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf16=vsub(Vu.qf16,Vv.qf16)
```

```
HVX_Vector Q6_Vqf16_vsub_Vqf16Vqf16(HVX_Vector
Vu, HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse			u5					d5								
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.qf16=vsub(Vu.qf16,Vv.qf16)
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.qf16=vsub(Vu.hf,Vv.hf)
0	0	0	1	1	1	1	1	0	1	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.qf16=vsub(Vu.qf16,Vv.hf)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Subtract - single precision vector by vector

Single precision (32-bit) subtract.

Syntax

```
Vd.qf32=vsub(Vu.qf32,Vv.qf32)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.qf32[i];
    v = Vv.qf32[i];
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_SF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_SF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u - sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)-sig_v
: (sig_u-(sig_v+sig));
    Vd.qf32[i] = rnd_sat(exp,sig,sig_low) ;
}
```

```
Vd.qf32=vsub(Vu.qf32,Vv.sf)
```

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.qf32[i];
    v = Vv.sf[i];
    if(v.sign) v.sig = (-1.0)*v.sig;
    if (u.exp>v.exp) {
        exp = u.exp+(u.sig==0.0)? (-
(FRAC_SF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+(v.sig==0.0)? (-
(FRAC_SF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    sig = sig_u - sig_v;
    sig_low = (u.exp>v.exp) ? (sig_u-sig)-sig_v
: (sig_u-(sig_v+sig));
    Vd.qf32[i] = rnd_sat(exp,sig,sig_low) ;
}
```

Syntax

```
Vd.qf32=vsub(Vu.sf,Vv.sf)
```

Behavior

```
for (i = 0; i < VELEM(32); i++) {
    u = Vu.sf[i];
    v = Vv.sf[i];
    if (u.exp>v.exp) {
        exp = u.exp+((u.sig==0.0)? (-
(FRAC_SF+1)):ilogb(u.sig));
        if (exp<v.exp) exp = v.exp;
    } else {
        exp = v.exp+((v.sig==0.0)? (-
(FRAC_SF+1)):ilogb(v.sig));
        if (exp<u.exp) exp = u.exp;
    }
    sig_u = ldexp(u.sig, u.exp-exp);
    sig_v = ldexp(v.sig, v.exp-exp);
    if((u.sign==0) && (v.sign==0)) {
        sig = sig_u - sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-sig)-
sig_v : (sig_u-(sig_v+sig));
    } else if(u.sign ^ v.sign){
        sig = sig_u + sig_v;
        sig_low = (u.exp>v.exp) ? (sig_u-
sig)+sig_v : (sig_v-sig)+sig_u;
    } else{
        sig = sig_v - sig_u;
        sig_low = (v.exp>u.exp) ? (sig_v-sig)-
sig_u : sig_v-(sig_u+sig);
    }
    Vd.qf32[i] = rnd_sat(exp,sig,sig_low);
    if((u.sign==1) && (v.sign==0)) Vd.qf32[i] =
-(Vd.qf32[i]) ;
}
```

Class: COPROC_VX (slots 0,1,2,3)**Notes**

- This instruction uses the HVX shift resource.

Intrinsics

```
Vd.qf32=vsub(Vu.qf32,Vv.qf32)
```

```
HVX_Vector Q6_Vqf32_vsub_Vqf32Vqf32 (HVX_Vector
Vu, HVX_Vector Vv)
```

```
Vd.qf32=vsub(Vu.qf32,Vv.sf)
```

```
HVX_Vector Q6_Vqf32_vsub_Vqf32Vsfc (HVX_Vector Vu,
HVX_Vector Vv)
```

```
Vd.qf32=vsub(Vu.sf,Vv.sf)
```

```
HVX_Vector Q6_Vqf32_vsub_VsfVsf (HVX_Vector Vu,
HVX_Vector Vv)
```

Encoding

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	
ICLASS																Parse		u5					d5									
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	0	1	1	d	d	d	d	d	Vd.qf32=vsub(Vu.qf32,Vv.qf32)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.qf32=vsub(Vu.sf,Vv.sf)
0	0	0	1	1	1	1	1	1	0	1	v	v	v	v	v	P	P	1	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.qf32=vsub(Vu.qf32,Vv.sf)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

Bit counting

The bit counting operations are applied to each vector element in a vector register Vu, and place the result in the corresponding element in the vector destination register Vd.

Count leading zeros (vcl0) counts the number of consecutive zeros starting with the most significant bit. It supports unsigned halfword and word. Population count (vpopcount) counts the number of nonzero bits in a halfword element. Normalization amount (vnormamt) counts the number of bits for normalization (consecutive sign bits minus one, with zero treated specially). Count leading identical bits, and add a value to it for each lane

Syntax	Behavior
Vd.h=vadd(vclb(Vu.h),Vv.h)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.h[i] = max(count_leading_ones(~Vu.h[i]),count_leading_ones (Vu.h[i])) + Vv.h[i]; }</pre>
Vd.h=vnormamt(Vu.h)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.h[i]=max(count_leading_ones(~Vu.h[i]),count_ leading_ones(Vu.h[i]))-1; }</pre>
Vd.h=vpopcount(Vu.h)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i]=count_ones(Vu.uh[i]); }</pre>
Vd.uh=vcl0(Vu.uh)	<pre>for (i = 0; i < VELEM(16); i++) { Vd.uh[i]=count_leading_ones(~Vu.uh[i]); }</pre>
Vd.uw=vcl0(Vu.uw)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.uw[i]=count_leading_ones(~Vu.uw[i]); }</pre>
Vd.w=vadd(vclb(Vu.w),Vv.w)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i] = max(count_leading_ones(~Vu.w[i]),count_leading_ones (Vu.w[i])) + Vv.w[i]; }</pre>
Vd.w=vnormamt(Vu.w)	<pre>for (i = 0; i < VELEM(32); i++) { Vd.w[i]=max(count_leading_ones(~Vu.w[i]),count_ leading_ones(Vu.w[i]))-1; }</pre>
Vd=vnormamth(Vu)	Assembler mapped to: "Vd.h=vnormamt(Vu.h)"
Vd=vnormamtw(Vu)	Assembler mapped to: "Vd.w=vnormamt(Vu.w)"

Class: COPROC_VX (slots 0,1,2,3)

Notes

- This instruction uses the HVX shift resource.

Intrinsics

Vd.h=vadd(vclb(Vu.h), Vv.h)	HVX_Vector Q6_Vh_vadd_vclb_VhVh(HVX_Vector Vu, HVX_Vector Vv)
Vd.h=vnormamt(Vu.h)	HVX_Vector Q6_Vh_vnormamt_Vh(HVX_Vector Vu)
Vd.h=vpopcount(Vu.h)	HVX_Vector Q6_Vh_vpopcount_Vh(HVX_Vector Vu)
Vd.uh=vcl0(Vu.uh)	HVX_Vector Q6_Vuh_vcl0_Vuh(HVX_Vector Vu)
Vd.uw=vcl0(Vu.uw)	HVX_Vector Q6_Vuw_vcl0_Vuw(HVX_Vector Vu)
Vd.w=vadd(vclb(Vu.w), Vv.w)	HVX_Vector Q6_Vw_vadd_vclb_VwVw(HVX_Vector Vu, HVX_Vector Vv)
Vd.w=vnormamt(Vu.w)	HVX_Vector Q6_Vw_vnormamt_Vw(HVX_Vector Vu)

Encoding

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	
ICLASS																Parse				u5					d5							
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.uw=vcl0(Vu.uw)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	1	1	0	d	d	d	d	d	Vd.h=vpopcount(Vu.h)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	0	P	P	0	u	u	u	u	u	1	1	1	d	d	d	d	d	Vd.uh=vcl0(Vu.uh)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	1	P	P	0	u	u	u	u	u	1	0	0	d	d	d	d	d	Vd.w=vnormamt(Vu.w)
0	0	0	1	1	1	1	0	-	-	0	-	-	-	1	1	P	P	0	u	u	u	u	u	1	0	1	d	d	d	d	d	Vd.h=vnormamt(Vu.h)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	0	d	d	d	d	d	Vd.h=vadd(vclb(Vu.h),Vv.h)
0	0	0	1	1	1	1	1	0	0	0	v	v	v	v	v	P	P	1	u	u	u	u	u	0	0	1	d	d	d	d	d	Vd.w=vadd(vclb(Vu.w),Vv.w)

Field name	Description
ICLASS	Instruction class
Parse	Packet/loop parse bits
d5	Field to encode register d
u5	Field to encode register u
v5	Field to encode register v

6.15 HVX/STORE

The HVX/STORE instruction subclass includes memory store instructions.

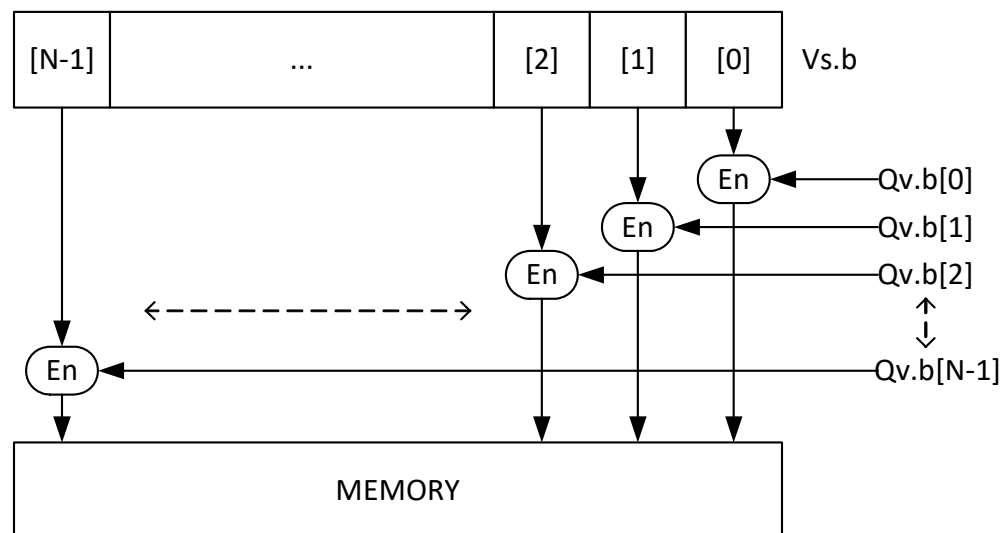
Store - byte-enabled aligned

Of the bytes in vector register Vs , store to memory only the ones where the corresponding bit in the predicate register Qv is enabled. The block of memory to store into is at a vector-size-aligned address. The operation has three ways to generate the memory pointer address: Rt with a constant 4-bit signed offset, Rx with a signed post-increment, and Rx with a modifier register Mu post-increment. For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset.

If all bits in Qv are set to zero, no data is stored to memory, but the post-increment of the pointer in Rt occurs.

If the pointer presented to the instruction is not aligned, the instruction ignores the lower bits, yielding an aligned address.

If ($Qv4$) $vmem(Rt) = Vs$



Syntax

```
if ([!]Qv4) vmem(Rt):nt=Vs
```

```
if ([!]Qv4) vmem(Rt)=Vs
```

```
if ([!]Qv4) vmem(Rt+#s4):nt=Vs
```

```
if ([!]Qv4) vmem(Rt+#s4)=Vs
```

Behavior

Assembler mapped to: "if ([!]Qv4)
 $vmem(Rt+\#0):nt=Vs$ "

Assembler mapped to: "if ([!]Qv4)
 $vmem(Rt+\#0)=Vs$ "

$EA=Rt+\#s*VBYTES$;
 $*(EA\&\sim(ALIGNMENT-1)) = Vs$;

$EA=Rt+\#s*VBYTES$;
 $*(EA\&\sim(ALIGNMENT-1)) = Vs$;

Syntax	Behavior
<code>if ([!]Qv4) vmem(Rx++#s3):nt=Vs</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+#s*VBYTES;
<code>if ([!]Qv4) vmem(Rx++#s3)=Vs</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+#s*VBYTES;
<code>if ([!]Qv4) vmem(Rx++Mu):nt=Vs</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+MuV;
<code>if ([!]Qv4) vmem(Rx++Mu)=Vs</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+MuV;

Class: COPROC_VMEM (slots 0)

Notes

- This instruction can use any HVX resource.
- An optional non-temporal hint to the micro-architecture can be specified to indicate the data has no reuse.
- immediates used in address computation are specified in multiples of vector length.

Intrinsics

<code>if (!Qv4) vmem(Rt+#s4):nt=Vs</code>	<code>void Q6_vmem_QnRIV_nt(HVX_VectorPred Qv, HVX_Vector* A, HVX_Vector Vs)</code>
<code>if (!Qv4) vmem(Rt+#s4)=Vs</code>	<code>void Q6_vmem_QnRIV(HVX_VectorPred Qv, HVX_Vector* A, HVX_Vector Vs)</code>
<code>if (Qv4) vmem(Rt+#s4):nt=Vs</code>	<code>void Q6_vmem_QRIV_nt(HVX_VectorPred Qv, HVX_Vector* A, HVX_Vector Vs)</code>
<code>if (Qv4) vmem(Rt+#s4)=Vs</code>	<code>void Q6_vmem_QRIV(HVX_VectorPred Qv, HVX_Vector* A, HVX_Vector Vs)</code>

Encoding

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	
ICLASS									NT	t5					Parse					s5												
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Qv4) vmem(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	1	0	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Qv4) vmem(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Qv4) vmem(Rt+#s4):nt=Vs
0	0	1	0	1	0	0	0	1	1	0	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Qv4) vmem(Rt+#s4):nt=Vs
ICLASS									NT	x5					Parse					s5												
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Qv4) vmem(Rx++#s3)=Vs
0	0	1	0	1	0	0	1	1	0	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Qv4) vmem(Rx++#s3)=Vs

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	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Qv4) vmem(Rx++#s3):nt=Vs
0	0	1	0	1	0	0	1	1	1	0	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Qv4) vmem(Rx++#s3):nt=Vs
ICLASS									NT	x5					Parse		u1											s5				
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	0	s	s	s	s	s	if (Qv4) vmem(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	1	0	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	1	s	s	s	s	s	if (!Qv4) vmem(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	0	s	s	s	s	s	if (Qv4) vmem(Rx++Mu):nt=Vs
0	0	1	0	1	0	1	1	1	1	0	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	1	s	s	s	s	s	if (!Qv4) vmem(Rx++Mu):nt=Vs

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s5	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Store - new

Store the result of an operation in the current packet to memory, using a vector-aligned address. The result is also written to the vector register file at the vector register location.

For example, in the instruction `vmem(R8++#1) = V12.new`, the value in V12 in this packet is written to memory, and V12 is also written to the vector register file.

The operation has three ways to generate the memory pointer address: Rt with a constant 4-bit signed offset, Rx with a 3-bit signed post-increment, and Rx with a modifier register Mu post-increment. For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset.

The store is conditional, based on the value of the scalar predicate register Pv. If the condition evaluates false, the operation becomes a NOP.

Syntax	Behavior
<pre>if ([!]Pv) vmem(Rt+#s4) :nt=Os8.new</pre>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; *(EA&~(ALIGNMENT-1)) = OsN.new; } else { NOP; }</pre>
<pre>if ([!]Pv) vmem(Rt+#s4)=Os8.new</pre>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; *(EA&~(ALIGNMENT-1)) = OsN.new; } else { NOP; }</pre>
<pre>if ([!]Pv) vmem(Rx++#s3) :nt=Os8.new</pre>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<pre>if ([!]Pv) vmem(Rx++#s3)=Os8.new</pre>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<pre>if ([!]Pv) vmem(Rx++Mu) :nt=Os8.new</pre>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+MuV; } else { NOP; }</pre>

Syntax	Behavior
<code>if ([!]Pv) vmem(Rx++Mu)=Os8.new</code>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+MuV; } else { NOP; }</pre>
<code>vmem(Rt):nt=Os8.new</code>	Assembler mapped to: "vmem(Rt+#0):nt=Os8.new"
<code>vmem(Rt)=Os8.new</code>	Assembler mapped to: "vmem(Rt+#0)=Os8.new"
<code>vmem(Rt+#s4):nt=Os8.new</code>	EA=Rt+#s*VBYTES; *(EA&~(ALIGNMENT-1)) = OsN.new;
<code>vmem(Rt+#s4)=Os8.new</code>	EA=Rt+#s*VBYTES; *(EA&~(ALIGNMENT-1)) = OsN.new;
<code>vmem(Rx++#s3):nt=Os8.new</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+#s*VBYTES;
<code>vmem(Rx++#s3)=Os8.new</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+#s*VBYTES;
<code>vmem(Rx++Mu):nt=Os8.new</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+MuV;
<code>vmem(Rx++Mu)=Os8.new</code>	EA=Rx; *(EA&~(ALIGNMENT-1)) = OsN.new; Rx=Rx+MuV;

Class: COPROC_VMEM (slots 0)

Notes

- This instruction can use any HVX resource.
- An optional non-temporal hint to the micro-architecture can be specified to indicate the data has no reuse.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS								NT	t5				Parse								s3											
0	0	1	0	1	0	0	0	0	0	1	t	t	t	t	t	P	P	i	-	-	i	i	i	0	0	1	-	0	s	s	s	vmem(Rt+#s4)=Os8.new
0	0	1	0	1	0	0	0	0	1	1	t	t	t	t	t	P	P	i	-	-	i	i	i	0	0	1	-	-	s	s	s	vmem(Rt+#s4):nt=Os8.new
0	0	1	0	1	0	0	0	1	0	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	0	0	0	s	s	s	if (Pv) vmem(Rt+#s4)=Os8.new
0	0	1	0	1	0	0	0	1	0	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	1	0	1	s	s	s	if (!Pv) vmem(Rt+#s4)=Os8.new
0	0	1	0	1	0	0	0	1	1	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	0	1	0	s	s	s	if (Pv) vmem(Rt+#s4):nt=Os8.new
0	0	1	0	1	0	0	0	1	1	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	1	1	1	1	s	s	s	if (!Pv) vmem(Rt+#s4):nt=Os8.new

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	
ICLASS									NT	x5					Parse					s3												
0	0	1	0	1	0	0	1	0	0	1	x	x	x	x	x	P	P	-	-	-	i	i	i	0	0	1	-	0	s	s	s	vmem(Rx++#s3)=Os8.new
0	0	1	0	1	0	0	1	0	1	1	x	x	x	x	x	P	P	-	-	-	i	i	i	0	0	1	-	-	s	s	s	vmem(Rx++#s3):nt=Os8.new
0	0	1	0	1	0	0	1	1	0	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	0	0	0	s	s	s	if (Pv) vmem(Rx++#s3)=Os8.new
0	0	1	0	1	0	0	1	1	0	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	1	0	1	s	s	s	if (!Pv) vmem(Rx++#s3)=Os8.new
0	0	1	0	1	0	0	1	1	1	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	0	1	0	s	s	s	if (Pv) vmem(Rx++#s3):nt=Os8.new
0	0	1	0	1	0	0	1	1	1	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	1	1	1	1	s	s	s	if (!Pv) vmem(Rx++#s3):nt=Os8.new
ICLASS									NT	x5					Parse	u1	s3															
0	0	1	0	1	0	1	1	0	0	1	x	x	x	x	x	P	P	u	-	-	-	-	-	0	0	1	-	0	s	s	s	vmem(Rx++Mu)=Os8.new
0	0	1	0	1	0	1	1	0	1	1	x	x	x	x	x	P	P	u	-	-	-	-	-	0	0	1	-	-	s	s	s	vmem(Rx++Mu):nt=Os8.new
0	0	1	0	1	0	1	1	1	0	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	0	0	0	s	s	s	if (Pv) vmem(Rx++Mu)=Os8.new
0	0	1	0	1	0	1	1	1	0	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	1	0	1	s	s	s	if (!Pv) vmem(Rx++Mu)=Os8.new
0	0	1	0	1	0	1	1	1	1	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	0	1	0	s	s	s	if (Pv) vmem(Rx++Mu):nt=Os8.new
0	0	1	0	1	0	1	1	1	1	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	1	1	1	1	s	s	s	if (!Pv) vmem(Rx++Mu):nt=Os8.new

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s3	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Store - aligned

Write a full vector register Vs to memory, using a vector-size-aligned address. The operation has three ways to generate the memory pointer address: Rt with a constant 4-bit signed offset, Rx with a signed post-increment, and Rx with a modifier register Mu post-increment. For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset.

If the pointer presented to the instruction is not aligned, the instruction ignores the lower bits, yielding an aligned address.

If a scalar predicate register Pv evaluates true, store a full vector register Vs to memory, using a vector-size-aligned address. Otherwise, the operation becomes a NOP

Syntax	Behavior
<code>if ([!]Pv) vmem(Rt):nt=Vs</code>	Assembler mapped to: "if ([!]Pv) vmem(Rt+#0):nt=Vs"
<code>if ([!]Pv) vmem(Rt)=Vs</code>	Assembler mapped to: "if ([!]Pv) vmem(Rt+#0)=Vs"
<code>if ([!]Pv) vmem(Rt+#s4):nt=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; *(EA&~(ALIGNMENT-1)) = Vs; } else { NOP; }</pre>
<code>if ([!]Pv) vmem(Rt+#s4)=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; *(EA&~(ALIGNMENT-1)) = Vs; } else { NOP; }</pre>
<code>if ([!]Pv) vmem(Rx++#s3):nt=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<code>if ([!]Pv) vmem(Rx++#s3)=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<code>if ([!]Pv) vmem(Rx++Mu):nt=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rx; *(EA&~(ALIGNMENT-1)) = Vs; Rx=Rx+MuV; } else { NOP; }</pre>

Syntax

```
if ([!]Pv) vmem(Rx++Mu)=Vs
```

Behavior

```
if ([!]Pv[0]) {
    EA=Rx;
    *(EA&~(ALIGNMENT-1)) = Vs;
    Rx=Rx+MuV;
} else {
    NOP;
}
```

```
vmem(Rt):nt=Vs
```

Assembler mapped to: "vmem(Rt+#0):nt=Vs"

```
vmem(Rt)=Vs
```

Assembler mapped to: "vmem(Rt+#0)=Vs"

```
vmem(Rt+#s4):nt=Vs
```

```
EA=Rt+#s*VBYTES;
*(EA&~(ALIGNMENT-1)) = Vs;
```

```
vmem(Rt+#s4)=Vs
```

```
EA=Rt+#s*VBYTES;
*(EA&~(ALIGNMENT-1)) = Vs;
```

```
vmem(Rx++#s3):nt=Vs
```

```
EA=Rx;
*(EA&~(ALIGNMENT-1)) = Vs;
Rx=Rx+#s*VBYTES;
```

```
vmem(Rx++#s3)=Vs
```

```
EA=Rx;
*(EA&~(ALIGNMENT-1)) = Vs;
Rx=Rx+#s*VBYTES;
```

```
vmem(Rx++Mu):nt=Vs
```

```
EA=Rx;
*(EA&~(ALIGNMENT-1)) = Vs;
Rx=Rx+MuV;
```

```
vmem(Rx++Mu)=Vs
```

```
EA=Rx;
*(EA&~(ALIGNMENT-1)) = Vs;
Rx=Rx+MuV;
```

Class: COPROC_VMEM (slots 0)**Notes**

- This instruction can use any HVX resource.
- An optional non-temporal hint to the micro-architecture can be specified to indicate the data has no reuse.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS			NT						t5					Parse					s5													
0	0	1	0	1	0	0	0	0	0	1	t	t	t	t	t	P	P	i	-	-	i	i	i	0	0	0	s	s	s	s	s	vmem(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	0	1	1	t	t	t	t	t	P	P	i	-	-	i	i	i	0	0	0	s	s	s	s	s	vmem(Rt+#s4):nt=Vs
0	0	1	0	1	0	0	0	1	0	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Pv) vmem(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	1	0	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Pv) vmem(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	1	1	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Pv) vmem(Rt+#s4):nt=Vs
0	0	1	0	1	0	0	0	1	1	1	t	t	t	t	t	P	P	i	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Pv) vmem(Rt+#s4):nt=Vs
ICLASS			NT						x5					Parse					s5													
0	0	1	0	1	0	0	1	0	0	1	x	x	x	x	x	P	P	-	-	-	i	i	i	0	0	0	s	s	s	s	s	vmem(Rx++#s3)=Vs

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	1	0	0	1	0	1	1	x	x	x	x	x	P	P	-	-	-	i	i	i	0	0	0	s	s	s	s	s	vmem(Rx++#s3):nt=Vs
0	0	1	0	1	0	0	1	1	0	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Pv) vmem(Rx++#s3)=Vs
0	0	1	0	1	0	0	1	1	0	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Pv) vmem(Rx++#s3)=Vs
0	0	1	0	1	0	0	1	1	1	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	0	s	s	s	s	s	if (Pv) vmem(Rx++#s3):nt=Vs
0	0	1	0	1	0	0	1	1	1	1	x	x	x	x	x	P	P	-	v	v	i	i	i	0	0	1	s	s	s	s	s	if (!Pv) vmem(Rx++#s3):nt=Vs
ICLASS					NT					x5					Parse					u1					s5							
0	0	1	0	1	0	1	1	0	0	1	x	x	x	x	x	P	P	u	-	-	-	-	-	0	0	0	s	s	s	s	s	vmem(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	0	1	1	x	x	x	x	x	P	P	u	-	-	-	-	-	0	0	0	s	s	s	s	s	vmem(Rx++Mu):nt=Vs
0	0	1	0	1	0	1	1	1	0	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	0	s	s	s	s	s	if (Pv) vmem(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	1	0	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	1	s	s	s	s	s	if (!Pv) vmem(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	1	1	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	0	s	s	s	s	s	if (Pv) vmem(Rx++Mu):nt=Vs
0	0	1	0	1	0	1	1	1	1	1	x	x	x	x	x	P	P	u	v	v	-	-	-	0	0	1	s	s	s	s	s	if (!Pv) vmem(Rx++Mu):nt=Vs

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s5	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Store - unaligned

Write a full vector register Vs to memory, using an arbitrary byte-aligned address. The operation has three ways to generate the memory pointer address: Rt with a constant 4-bit signed offset, Rx with a 3-bit signed post-increment, and Rx with a modifier register Mu post-increment. For the immediate forms, the value indicates the number of vectors worth of data. Mu contains the actual byte offset.

Unaligned memory operations require two accesses to the memory system, and thus incur increased power and bandwidth over aligned accesses. However, they require fewer instructions. Care should be taken to use aligned memory operations and combinations of permute operations, when possible.

This instruction uses both slot 0 and slot 1, allowing only 3 instructions at most to execute in a packet with `vmemu` in it.

If the scalar predicate register Pv is true, store a full vector register Vs to memory, using an arbitrary byte-aligned address. Otherwise, the operation becomes a NOP.

Syntax	Behavior
<code>if ([!]Pv) vmemu(Rt)=Vs</code>	Assembler mapped to: "if ([!]Pv) vmemu(Rt+#0)=Vs"
<code>if ([!]Pv) vmemu(Rt+#s4)=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rt+#s*VBYTES; *EA = Vs; } else { NOP; }</pre>
<code>if ([!]Pv) vmemu(Rx++#s3)=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rx; *EA = Vs; Rx=Rx+#s*VBYTES; } else { NOP; }</pre>
<code>if ([!]Pv) vmemu(Rx++Mu)=Vs</code>	<pre>if ([!]Pv[0]) { EA=Rx; *EA = Vs; Rx=Rx+MuV; } else { NOP; }</pre>
<code>vmemu(Rt)=Vs</code>	Assembler mapped to: "vmemu(Rt+#0)=Vs"
<code>vmemu(Rt+#s4)=Vs</code>	<pre>EA=Rt+#s*VBYTES; *EA = Vs;</pre>
<code>vmemu(Rx++#s3)=Vs</code>	<pre>EA=Rx; *EA = Vs; Rx=Rx+#s*VBYTES;</pre>
<code>vmemu(Rx++Mu)=Vs</code>	<pre>EA=Rx; *EA = Vs; Rx=Rx+MuV;</pre>

Class: COPROC_VMEM (slots 0)**Notes**

- This instruction uses the HVX permute resource.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS									NT	t5					Parse					s5												
0	0	1	0	1	0	0	0	0	0	1	t	t	t	t	t	P	P	i	-	-	i	i	i	1	1	1	s	s	s	s	s	vmemu(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	1	0	1	t	t	t	t	t	P	P	i	v	v	i	i	i	1	1	0	s	s	s	s	s	if (Pv) vmemu(Rt+#s4)=Vs
0	0	1	0	1	0	0	0	1	0	1	t	t	t	t	t	P	P	i	v	v	i	i	i	1	1	1	s	s	s	s	s	if (!Pv) vmemu(Rt+#s4)=Vs
ICLASS									NT	x5					Parse					s5												
0	0	1	0	1	0	0	1	0	0	1	x	x	x	x	x	P	P	-	-	-	i	i	i	1	1	1	s	s	s	s	s	vmemu(Rx++#s3)=Vs
0	0	1	0	1	0	0	1	1	0	1	x	x	x	x	x	P	P	-	v	v	i	i	i	1	1	0	s	s	s	s	s	if (Pv) vmemu(Rx++#s3)=Vs
0	0	1	0	1	0	0	1	1	0	1	x	x	x	x	x	P	P	-	v	v	i	i	i	1	1	1	s	s	s	s	s	if (!Pv) vmemu(Rx++#s3)=Vs
ICLASS									NT	x5					Parse	u1						s5										
0	0	1	0	1	0	1	1	0	0	1	x	x	x	x	x	P	P	u	-	-	-	-	-	1	1	1	s	s	s	s	s	vmemu(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	1	0	1	x	x	x	x	x	P	P	u	v	v	-	-	-	1	1	0	s	s	s	s	s	if (Pv) vmemu(Rx++Mu)=Vs
0	0	1	0	1	0	1	1	1	0	1	x	x	x	x	x	P	P	u	v	v	-	-	-	1	1	1	s	s	s	s	s	if (!Pv) vmemu(Rx++Mu)=Vs

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
s5	Field to encode register s
t5	Field to encode register t
u1	Field to encode register u
v2	Field to encode register v
x5	Field to encode register x

Scatter release

Specialized store that follows outstanding scatters or gathers to make sure they complete. When the scatter release address is written to VTCM space, no data is actually stored.

A VMEM load from that scatter release address causes a stalling synchronization until the scatter release operation completes and thus all older scatter and gather operations.

The EA of the store release must be in the VTCM, otherwise it is dropped

The following code sequence demonstrates the proper usage of a scatter release used for synchronization.

```
vscatter(r0, m0, v1.h) = v4.h; // Issue a scatter operation
...
vscatter(r0, m0, v2.h) = v5.h; // Issue another scatter operation
...
vmem(r10):scatter_release; // Scatter release to address in VTCM pointed to by r10
...
v31 = vmem(r10); // Load from VTCM address in r10, when this load completes
// all prior scatters and gathers for the current context have
// completed
```

Syntax	Behavior
<code>vmem(Rt+#s4):scatter_release</code>	EA=Rt+#s*VBYTES; char* addr = EA~(ALIGNMENT-1); Zero Byte Store Release (Non-blocking Sync);
<code>vmem(Rx++#s3):scatter_release</code>	EA=Rx; char* addr = EA~(ALIGNMENT-1); Zero Byte Store Release (Non-blocking Sync); Rx=Rx+#s*VBYTES;
<code>vmem(Rx++Mu):scatter_release</code>	EA=Rx; char* addr = EA~(ALIGNMENT-1); Zero Byte Store Release (Non-blocking Sync); Rx=Rx+MuV;

Class: COPROC_VMEM (slots 0)

Notes

- This instruction can use any HVX resource.
- immediates used in address computation are specified in multiples of vector length.

Encoding

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	
ICLASS									NT	t5					Parse																	
0	0	1	0	1	0	0	0	0	0	1	t	t	t	t	t	P	P	i	-	-	i	i	i	0	0	1	-	1	-	-	-	vmem(Rt+#s4):scatter_release
ICLASS									NT	x5					Parse																	
0	0	1	0	1	0	0	1	0	0	1	x	x	x	x	x	P	P	-	-	-	i	i	i	0	0	1	-	1	-	-	-	vmem(Rx++#s3):scatter_release
ICLASS									NT	x5					Parse	u1																
0	0	1	0	1	0	1	1	0	0	1	x	x	x	x	x	P	P	u	-	-	-	-	-	0	0	1	-	1	-	-	-	vmem(Rx++Mu):scatter_release

Field name	Description
ICLASS	Instruction class
NT	NonTemporal
Parse	Packet/loop parse bits
t5	Field to encode register t
u1	Field to encode register u
x5	Field to encode register x

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