0.1. ORBIS32/64

l.add Add Signed l.add

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x0
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.add rD,rA,rB
```

Description:

The contents of general-purpose register rA are added to the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] + rB[31:0]
SR[CY] <- carry
SR[OV] <- overflow
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] + rB[63:0]
SR[CY] <- carry
SR[OV] <- overflow
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.addc Add Signed and Carry l.addc

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x1
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.addc rD,rA,rB
```

Description:

The contents of general-purpose register rA are added to the contents of general-purpose register rB and carry SR[CY] to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] + rB[31:0] + SR[CY]
SR[CY] <- carry
SR[OV] <- overflow
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] + rB[63:0] + SR[CY]
SR[CY] <- carry
SR[OV] <- overflow
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.addi Add Immediate Signed l.addi

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x27	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.addi rD,rA,I
```

Description:

The immediate value is sign-extended and added to the contents of general-purposeregister rA to form the result. The result is placed into general-purposeregister rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] + exts(Immediate)
SR[CY] <- carry
SR[OV] <- overflow
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] + exts(Immediate)
SR[CY] <- carry
SR[OV] <- overflow
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.addic Add Immediate Signed and Carry l.addic

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x28	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.addic rD,rA,I
```

Description:

The immediate value is sign-extended and added to the contents of general-purposeregister rA and carry SR[CY] to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] + exts(Immediate) + SR[CY]
SR[CY] <- carry
SR[OV] <- overflow
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] + exts(Immediate) + SR[CY]
SR[CY] <- carry
SR[OV] <- overflow
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.and **And** **l.and**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x3
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.and rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical AND operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] AND rB[31:0]
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] AND rB[63:0]
```

Exceptions:

```
None
```

l.andi **And with Immediate Half Word** **l.andi**

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x29	D	A	K
6 bits	5 bits	5 bits	16bits

Format:

```
l.andi rD,rA,K
```

Description:

The immediate value is zero-extended and combined with the contents of general-purpose register rA in a bit-wise logical AND operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] AND extz(Immediate)
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] AND extz(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.bf Branch if Flag l.bf

31 26	25 0
opcode 0x4	N
6 bits	26bits

Format:

```
l.bf N
```

Description:

The immediate value is shifted left two bits, sign-extended to program counter width, and then added to the address of the branch instruction. The result is the effective address of the branch. If the flag is set, the program branches to EA with a delay of one instruction.

32-bit Implementation:

```
EA <- exts(Immediate << 2) + BranchInsnAddr
PC <- EA if SR[F] set
```

64-bit Implementation:

```
EA <- exts(Immediate << 2) + BranchInsnAddr
PC <- EA if SR[F] set
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.bnf — Branch if No Flag — l.bnf

31 26	25 0
opcode 0x3	N
6 bits	26bits

Format:

```
l.bnf N
```

Description:

The immediate value is shifted left two bits, sign-extended to program counter width, and then added to the address of the branch instruction. The result is the effective address of the branch. If the flag is cleared, the program branches to EA with a delay of one instruction.

32-bit Implementation:

```
EA <- exts(Immediate << 2) + BranchInsnAddr
PC <- EA if SR[F] cleared
```

64-bit Implementation:

```
EA <- exts(Immediate << 2) + BranchInsnAddr
PC <- EA if SR[F] cleared
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.cmov **Conditional Move** **l.cmov**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0xe
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.cmov rD,rA,rB
```

Description:

If SR[F] is set, general-purpose register rA is placed in general-purpose register rD. If SR[F] is cleared, general-purpose register rB is placed in general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- SR[F] ? rA[31:0] :  rB[31:0]
```

64-bit Implementation:

```
rD[63:0] <- SR[F] ? rA[63:0] :  rB[63:0]
```

Exceptions:

```
None
```

l.csync Context Syncronization l.csync

31 0
opcode 0x23000000
32bits

Format:

```
l.csync
```

Description:

Execution of context synchronization instruction results in completion of all operations inside the processor and a flush of the instruction pipelines. When all operations are complete, the RISC core resumes with an empty instruction pipeline and fresh context in all units (MMU for example).

32-bit Implementation:

```
context-synchronization
```

64-bit Implementation:

```
context-synchronization
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.cust1 Reserved for ORBIS32/64 Custom Instructions l.cust1

31 26	25 0
opcode 0x1c	reserved
6 bits	26bits

Format:

```
l.cust1
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

Instruction Class
ORBIS32 II

l.cust2 Reserved for ORBIS32/64 Custom Instructions l.cust2

31 26	25 0
opcode 0x1d	reserved
6 bits	26bits

Format:

```
l.cust2
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

l.cust3 Reserved for ORBIS32/64 Custom Instructions l.cust3

31 26	25 0
opcode 0x1e	reserved
6 bits	26bits

Format:

```
l.cust3
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

Instruction Class
ORBIS32 II

l.cust4 Reserved for ORBIS32/64 Custom Instructions l.cust4

31 26	25 0
opcode 0x1f	reserved
6 bits	26bits

Format:

```
l.cust4
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

Instruction Class
ORBIS32 II

l.cust5 Reserved for ORBIS32/64 Custom Instructions l.cust5

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 5	4 . . . 0
opcode 0x3c	D	A	B	L	K
6 bits	5 bits	5 bits	5 bits	6 bits	5bits

Format:

```
l.cust5 rD,rA,rB,L,K
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

Instruction Class
ORBIS32 II

l.cust6 Reserved for ORBIS32/64 Custom Instructions l.cust6

31 26	25 0
opcode 0x3d	reserved
6 bits	26bits

Format:

```
l.cust6
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

l.cust7 Reserved for ORBIS32/64 Custom Instructions l.cust7

31 26	25 0
opcode 0x3e	reserved
6 bits	26bits

Format:

```
l.cust7
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

l.cust8 Reserved for ORBIS32/64 Custom Instructions l.cust8

31 26	25 0
opcode 0x3f	reserved
6 bits	26bits

Format:

```
l.cust8
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but rather by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

l.div **Divide Signed** **l.div**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x3	reserved	opcode 0x9
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.div rD,rA,rB
```

Description:

The content of general-purpose register rA are divided by the content of general-purpose register rB, and the result is placed into general-purpose register rD. Both operands are treated as signed integers. A carry flag is set when the divisor is zero (if carry SR[CY] is implemented).

32-bit Implementation:

```
rD[31:0] <- rA[31:0] / rB[31:0]
SR[OV] <- overflow
SR[CY] <- carry
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] / rB[63:0]
SR[OV] <- overflow
SR[CY] <- carry
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 II

l.divu Divide Unsigned l.divu

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x3	reserved	opcode 0xa
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.divu rD,rA,rB
```

Description:

The content of general-purpose register rA are divided by the content of general-purpose register rB, and the result is placed into general-purpose register rD. Both operands are treated as unsigned integers. A carry flag is set when the divisor is zero (if carry SR[CY] is implemented).

32-bit Implementation:

```
rD[31:0] <- rA[31:0] / rB[31:0]
SR[OV] <- overflow
SR[CY] <- carry
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] / rB[63:0]
SR[OV] <- overflow
SR[CY] <- carry
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 II

l.extbs Extend Byte with Sign l.extbs

31 26	25 . . . 21	20 . . . 16	15 10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	reserved	opcode 0x1	reserved	opcode 0xc
6 bits	5 bits	5 bits	6 bits	4 bits	2 bits	4bits

Format:

```
l.extbs rD,rA
```

Description:

Bit 7 of general-purpose register rA is placed in high-order bits of general-purpose register rD. The low-order eight bits of general-purpose register rA are copied into the low-order eight bits of general-purpose register rD.

32-bit Implementation:

```
rD[31:8] <- rA[7]
rD[7:0] <- rA[7:0]
```

64-bit Implementation:

```
rD[63:8] <- rA[7]
rD[7:0] <- rA[7:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.extbz **Extend Byte with Zero** **l.extbz**

31 26	25 . . . 21	20 . . . 16	15 10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	reserved	opcode 0x3	reserved	opcode 0xc
6 bits	5 bits	5 bits	6 bits	4 bits	2 bits	4bits

Format:

```
l.extbz rD,rA
```

Description:

Zero is placed in high-order bits of general-purpose register rD. The low-order eight bits of general-purpose register rA are copied into the low-order eight bits of general-purpose register rD.

32-bit Implementation:

```
rD[31:8] <- 0
rD[7:0] <- rA[7:0]
```

64-bit Implementation:

```
rD[63:8] <- 0
rD[7:0] <- rA[7:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.exths Extend Half Word with Sign l.exths

31 26	25 . . . 21	20 . . . 16	15 10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	reserved	opcode 0x0	reserved	opcode 0xc
6 bits	5 bits	5 bits	6 bits	4 bits	2 bits	4bits

Format:

```
l.exths rD,rA
```

Description:

Bit 15 of general-purpose register rA is placed in high-order bits of general-purpose register rD. The low-order 16 bits of general-purpose register rA are copied into the low-order 16 bits of general-purpose register rD.

32-bit Implementation:

```
rD[31:16] <- rA[15]
rD[15:0] <- rA[15:0]
```

64-bit Implementation:

```
rD[63:16] <- rA[15]
rD[15:0] <- rA[15:0]
```

Exceptions:

```
None
```

l.exthz Extend Half Word with Zero l.exthz

31 26	25 . . . 21	20 . . . 16	15 10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	reserved	opcode 0x2	reserved	opcode 0xc
6 bits	5 bits	5 bits	6 bits	4 bits	2 bits	4bits

Format:

```
l.exthz rD,rA
```

Description:

Zero is placed in high-order bits of general-purpose register rD. The low-order 16 bits of general-purpose register rA are copied into the low-order 16 bits of general-purpose register rD.

32-bit Implementation:

```
rD[31:16] <- 0
rD[15:0] <- rA[15:0]
```

64-bit Implementation:

```
rD[63:16] <- 0
rD[15:0] <- rA[15:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.extws Extend Word with Sign l.extws

31 26	25 . . . 21	20 . . . 16	15 10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	reserved	opcode 0x0	reserved	opcode 0xd
6 bits	5 bits	5 bits	6 bits	4 bits	2 bits	4bits

Format:

```
l.extws rD,rA
```

Description:

Bit 31 of general-purpose register rA is placed in high-order bits of general-purpose register rD. The low-order 32 bits of general-purpose register rA are copied from low-order 32 bits of general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0]
```

64-bit Implementation:

```
rD[63:32] <- rA[31]
rD[31:0] <- rA[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS64 II

l.extwz Extend Word with Zero l.extwz

31 26	25 . . . 21	20 . . . 16	15 10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	reserved	opcode 0x1	reserved	opcode 0xd
6 bits	5 bits	5 bits	6 bits	4 bits	2 bits	4bits

Format:

```
l.extwz rD,rA
```

Description:

Zero is placed in high-order bits of general-purpose register rD. The low-order 32 bits of general-purpose register rA are copied into the low-order 32 bits of general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0]
```

64-bit Implementation:

```
rD[63:32] <- 0
rD[31:0] <- rA[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS64 II

l.ff1 Find First 1 l.ff1

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0xf
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.ff1 rD,rA,rB
```

Description:

Position of the first '1' bit is written into general-purpose register rD. Checking for bit '1' starts with MSB, and counting is decremented for every zero bit. If first '1' bit is discovered in LSB, one is written into rD. If there is no '1' bit, zero is written in rD.

32-bit Implementation:

```
rD[31:0] <- rA[31] ? 32 : rA[30] ? 31 ... rA[0] ? 1 : 0
```

64-bit Implementation:

```
rD[63:0] <- rA[63] ? 64 : rA[62] ? 63 ... rA[0] ? 1 : 0
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.j　　　Jump　　　l.j

31 26	25 0
opcode 0x0	N
6 bits	26bits

Format:

```
l.j N
```

Description:

The immediate value is shifted left two bits, sign-extended to program counter width, and then added to the address of the jump instruction. The result is the effective address of the jump. The program unconditionally jumps to EA with a delay of one instruction.

32-bit Implementation:

```
PC <- exts(Immediate << 2) + JumpInsnAddr
```

64-bit Implementation:

```
PC <- exts(Immediate << 2) + JumpInsnAddr
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.jal Jump and Link l.jal

31 26	25 0
opcode 0x1	N
6 bits	26bits

Format:

```
l.jal N
```

Description:

The immediate value is shifted left two bits, sign-extended to program counter width, and then added to the address of the jump instruction. The result is the effective address of the jump. The program unconditionally jumps to EA with a delay of one instruction. The address of the instruction after the delay slot is placed in the link register.

32-bit Implementation:

```
PC <- exts(Immediate << 2) + JumpInsnAddr
LR <- DelayInsnAddr + 4
```

64-bit Implementation:

```
PC <- exts(Immediate << 2) + JumpInsnAddr
LR <- DelayInsnAddr + 4
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.jalr Jump and Link Register l.jalr

31 26	25 16	15 . . . 11	10 0
opcode 0x12	reserved	B	reserved
6 bits	10 bits	5 bits	11bits

Format:

```
l.jalr rB
```

Description:

The contents of general-purpose register rB is the effective address of the jump. The program unconditionally jumps to EA with a delay of one instruction. The address of the instruction after the delay slot is placed in the link register. It is not allowed to specify link register as rB.

32-bit Implementation:

```
PC <- rB
LR <- DelayInsnAddr + 4
```

64-bit Implementation:

```
PC <- rB
LR <- DelayInsnAddr + 4
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.jr **Jump Register** **l.jr**

31 26	25 16	15 . . . 11	10 0
opcode 0x11	reserved	B	reserved
6 bits	10 bits	5 bits	11bits

Format:

```
l.jr rB
```

Description:

The contents of general-purpose register rB is the effective address of the jump. The program unconditionally jumps to EA with a delay of one instruction.

32-bit Implementation:

```
PC <- rB
```

64-bit Implementation:

```
PC <- rB
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.lbs Load Byte and Extend with Sign l.lbs

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x24	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.lbs rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The byte in memory addressed by EA is loaded into the low-order eight bits of general-purpose register rD. High-order bits of general-purpose register rD are replaced with bit 7 of the loaded value.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
rD[7:0] <- (EA)[7:0]
rD[31:8] <- (EA)[7]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[7:0] <- (EA)[7:0]
rD[63:8] <- (EA)[7]
```

Exceptions:

```
TLB miss
Page fault
Bus error
```

Instruction Class
ORBIS32 I

l.lbz Load Byte and Extend with Zero l.lbz

31 26	25 21	20 16	15 0
opcode 0x23	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.lbz rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The byte in memory addressed by EA is loaded into the low-order eight bits of general-purpose register rD. High-order bits of general-purpose register rD are replaced with zero.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
rD[7:0] <- (EA)[7:0]
rD[31:8] <- 0
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[7:0] <- (EA)[7:0]
rD[63:8] <- 0
```

Exceptions:

```
TLB miss
Page fault
Bus error
```

Instruction Class
ORBIS32 I

l.ld Load Double Word l.ld

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x20	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.ld rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The double word in memory addressed by EA is loaded into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[63:0] <- (EA)[63:0]
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS64 I

l.lhs Load Half Word and Extend with Sign l.lhs

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x26	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.lhs rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The half word in memory addressed by EA is loaded into the low-order 16 bits of general-purpose register rD. High-order bits of general-purpose register rD are replaced with bit 15 of the loaded value.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
rD[15:0] <- (EA)[15:0]
rD[31:16] <- (EA)[15]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[15:0] <- (EA)[15:0]
rD[63:16] <- (EA)[15]
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS32 I

l.lhz Load Half Word and Extend with Zero l.lhz

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x25	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.lhz rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The half word in memory addressed by EA is loaded into the low-order 16 bits of general-purpose register rD. High-order bits of general-purpose register rD are replaced with zero.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
rD[15:0] <- (EA)[15:0]
rD[31:16] <- 0
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[15:0] <- (EA)[15:0]
rD[63:16] <- 0
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS32 I

l.lws Load Single Word and Extend with Sign l.lws

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x22	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.lws rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The single word in memory addressed by EA is loaded into the low-order 32 bits of general-purpose register rD. High-order bits of general-purpose register rD are replaced with bit 31 of the loaded value.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
rD[31:0] <- (EA)[31:0]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[31:0] <- (EA)[31:0]
rD[63:32] <- (EA)[31]
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS32 I

l.lwz Load Single Word and Extend with Zero l.lwz

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x21	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.lwz rD,I(rA)
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The single word in memory addressed by EA is loaded into the low-order 32 bits of general-purpose register rD. High-order bits of general-purpose register rD are replaced with zero.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
rD[31:0] <- (EA)[31:0]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
rD[31:0] <- (EA)[31:0]
rD[63:32] <- 0
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS32 I

l.mac **Multiply Signed and Accumulate** **l.mac**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 4	3 . . 0
opcode 0x31	reserved	A	B	reserved	opcode 0x1
6 bits	5 bits	5 bits	5 bits	7 bits	4bits

Format:

```
l.mac rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are multiplied, and the result is truncated to 32 bits and added to the special-purpose registers MACHI and MACLO. All operands are treated as signed integers.

32-bit Implementation:

```
temp[31:0] <- rA[31:0] * rB[31:0]
MACHI[31:0]MACLO[31:0] <- temp[31:0] + MACHI[31:0]MACLO[31:0]
```

64-bit Implementation:

```
temp[31:0] <- rA[63:0] * rB[63:0]
MACHI[31:0]MACLO[31:0] <- temp[31:0] + MACHI[31:0]MACLO[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.maci Multiply Immediate Signed and Accumulate l.maci

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 0
opcode 0x13	I	reserved	B	I
6 bits	5 bits	5 bits	5 bits	11bits

Format:

```
l.maci rB,I
```

Description:

The immediate value and the contents of general-purpose register rA are multiplied, and the result is truncated to 32 bits and added to the special-purpose registers MACHI and MACLO. All operands are treated as signed integers.

32-bit Implementation:

```
temp[31:0] <- rA[31:0] * exts(Immediate)
MACHI[31:0]MACLO[31:0] <- temp[31:0] + MACHI[31:0]MACLO[31:0]
```

64-bit Implementation:

```
temp[31:0] <- rA[63:0] * exts(Immediate)
MACHI[31:0]MACLO[31:0] <- temp[31:0] + MACHI[31:0]MACLO[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.macrc **MAC Read and Clear** **l.macrc**

31 26	25 . . . 21	20 . . 17	16 0
opcode 0x6	D	reserved	opcode 0x10000
6 bits	5 bits	4 bits	17bits

Format:

```
l.macrc rD
```

Description:

Once all instructions in MAC pipeline are completed, the contents of MAC is placed into general-purpose register rD and MAC accumulator is cleared.

32-bit Implementation:

```
synchronize-mac
rD[31:0] <- MACLO[31:0]
MACHI[31:0]MACLO[31:0] <- 0
```

64-bit Implementation:

```
synchronize-mac
rD[63:0] <- MACHI[31:0]MACLO[31:0]
MACHI[31:0]MACLO[31:0] <- 0
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.mfspr Move From Special-Purpose Register l.mfspr

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x2d	D	A	K
6 bits	5 bits	5 bits	16bits

Format:

```
l.mfspr rD,rA,K
```

Description:

The contents of the special register, defined by contents of general-purpose rA logically ORed with immediate value, are moved into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- spr(rA OR Immediate)
```

64-bit Implementation:

```
rD[63:0] <- spr(rA OR Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.movhi Move Immediate High l.movhi

31 26	25 . . . 21	20 . . 17	16	15 0
opcode 0x6	D	reserved	opcode 0x0	K
6 bits	5 bits	4 bits	1 bits	16bits

Format:

```
l.movhi rD,K
```

Description:

The 16-bit immediate value is zero-extended, shifted left by 16 bits, and placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- extz(Immediate) << 16
```

64-bit Implementation:

```
rD[63:0] <- extz(Immediate) << 16
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.msb Multiply Signed and Subtract l.msb

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 4	3 . . 0
opcode 0x31	reserved	A	B	reserved	opcode 0x2
6 bits	5 bits	5 bits	5 bits	7 bits	4bits

Format:

```
l.msb rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are multiplied, and the result is truncated to 32 bits and subtracted from the special-purpose registers MACHI and MACLO. Result of the subtraction is placed into MACHI and MACLO registers.All operands are treated as signed integers.

32-bit Implementation:

```
temp[31:0] <- rA[31:0] * rB[31:0]
MACHI[31:0]MACLO[31:0] <- MACHI[31:0]MACLO[31:0] - temp[31:0]
```

64-bit Implementation:

```
temp[31:0] <- rA[63:0] * rB[63:0]
MACHI[31:0]MACLO[31:0] <- MACHI[31:0]MACLO[31:0] - temp[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.msync **Memory Syncronization** **l.msync**

31 0
opcode 0x22000000
32bits

Format:

```
l.msync
```

Description:

Execution of the memory synchronization instruction results in completion of all load/store operations before the RISC core continues.

32-bit Implementation:

```
memory-synchronization
```

64-bit Implementation:

```
memory-synchronization
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.mtspr **Move To Special-Purpose Register** **l.mtspr**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 0
opcode 0x30	K	A	B	K
6 bits	5 bits	5 bits	5 bits	11bits

Format:

```
l.mtspr rA,rB,K
```

Description:

The contents of general-purpose register rB are moved into the special register defined by contents of general-purpose register rA logically ORed with the immediate value.

32-bit Implementation:

```
spr(rA OR Immediate) <- rB[31:0]
```

64-bit Implementation:

```
spr(rA OR Immediate) <- rB[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.mul Multiply Signed l.mul

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x3	reserved	opcode 0x6
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.mul rD,rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are multiplied, and the result is truncated to destination register width and placed into general-purpose register rD. Both operands are treated as signed integers.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] * rB[31:0]
SR[OV] <- overflow
SR[CY] <- carry
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] * rB[63:0]
SR[OV] <- overflow
SR[CY] <- carry
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.muli **Multiply Immediate Signed** **l.muli**

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x2c	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.muli rD,rA,I
```

Description:

The immediate value and the contents of general-purpose register rA are multiplied, and the result is truncated to destination register width and placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] * Immediate
SR[OV] <- overflow
SR[CY] <- carry
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] * Immediate
SR[OV] <- overflow
SR[CY] <- carry
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.mulu **Multiply Unsigned** **l.mulu**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x3	reserved	opcode 0xb
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.mulu rD,rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are multiplied, and the result is truncated to destination register width and placed into general-purpose register rD. Both operands are treated as unsigned integers.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] * rB[31:0]
SR[OV] <- overflow
SR[CY] <- carry
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] * rB[63:0]
SR[OV] <- overflow
SR[CY] <- carry
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.nop No Operation l.nop

31 24	23 16	15 0
opcode 0x15	reserved	K
8 bits	8 bits	16bits

Format:

```
l.nop K
```

Description:

This instruction does not do anything except that it takes at least one clock cycle to complete. It is often used to fill delay slot gaps.Immediate value can be used for simulation purposes.

32-bit Implementation:

64-bit Implementation:

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.or **Or** **l.or**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x4
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.or rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical OR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] OR rB[31:0]
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] OR rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.ori **Or with Immediate Half Word** **l.ori**

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x2a	D	A	K
6 bits	5 bits	5 bits	16bits

Format:

```
l.ori rD,rA,K
```

Description:

The immediate value is zero-extended and combined with the contents of general-purpose register rA in a bit-wise logical OR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] OR extz(Immediate)
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] OR extz(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.psync	**Pipeline Syncronization**	**l.psync**

31 0
opcode 0x22800000
32bits

Format:

```
l.psync
```

Description:

Execution of pipeline synchronization instruction results in completion of all instructions that were fetched before l.psync instruction. Once all instructions are completed, instructions fetched after l.psync are flushed from the pipeline and fetched again.

32-bit Implementation:

```
pipeline-synchronization
```

64-bit Implementation:

```
pipeline-synchronization
```

Exceptions:

```
None
```

l.rfe　　Return From Exception　　l.rfe

31 26	25 0
opcode 0x9	reserved
6 bits	26bits

Format:

```
l.rfe
```

Description:

Execution of this instruction partially restores the state of the processor prior to the exception. This instruction does not have a delay slot.

32-bit Implementation:

```
PC <- EPCR
SR <- ESR
```

64-bit Implementation:

```
PC <- EPCR
SR <- ESR
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.ror **Rotate Right** **l.ror**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x3	reserved	opcode 0x8
6 bits	5 bits	5 bits	5 bits	1 bits	4 bits	2 bits	4bits

Format:

```
l.ror rD,rA,rB
```

Description:

General-purpose register rB specifies the number of bit positions; the contents of general-purpose register rA are rotated right. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of rB is ignored.

32-bit Implementation:

```
rD[31-rB[4:0]:0] <- rA[31:rB]
rD[31:32-rB[4:0]] <- rA[rB[4:0]-1:0]
```

64-bit Implementation:

```
rD[63-rB[5:0]:0] <- rA[63:rB]
rD[63:64-rB[5:0]] <- rA[rB[5:0]-1:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.rori	Rotate Right with Immediate	l.rori

31 26	25 . . . 21	20 . . . 16	15 8	7 6	5 0
opcode 0x2e	D	A	reserved	opcode 0x3	L
6 bits	5 bits	5 bits	8 bits	2 bits	6bits

Format:

```
l.rori rD,rA,L
```

Description:

The 6-bit immediate value specifies the number of bit positions; the contents of general-purpose register rA are rotated right. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of immediate is ignored.

32-bit Implementation:

```
rD[31-L:0] <- rA[31:L]
rD[31:32-L] <- rA[L-1:0]
```

64-bit Implementation:

```
rD[63-L:0] <- rA[63:L]
rD[63:64-L] <- rA[L-1:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sb **Store Byte** **l.sb**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 0
opcode 0x36	I	A	B	I
6 bits	5 bits	5 bits	5 bits	11bits

Format:

```
l.sb I(rA),rB
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The low-order 8 bits of general-purpose register rB are stored to memory location addressed by EA.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
(EA)[7:0] <- rB[7:0]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
(EA)[7:0] <- rB[7:0]
```

Exceptions:

```
TLB miss
Page fault
Bus error
```

Instruction Class
ORBIS32 I

l.sd Store Double Word l.sd

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 0
opcode 0x34	I	A	B	I
6 bits	5 bits	5 bits	5 bits	11bits

Format:

```
l.sd I(rA),rB
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The double word in general-purpose register rB is stored to memory location addressed by EA.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
(EA)[63:0] <- rB[63:0]
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS64 I

l.sfeq	**Set Flag if Equal**	**l.sfeq**

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x720	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfeq rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared. If the contents are equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] == rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] == rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfeqi Set Flag if Equal Immediate l.sfeqi

31 21	20 . . . 16	15 0
opcode 0x5e0	A	I
11 bits	5 bits	16bits

Format:

```
l.sfeqi rA,I
```

Description:

The contents of general-purpose register rA and the sign-extended immediate value are compared. If the two values are equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] == exts(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] == exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfges Set Flag if Greater or Equal Than Signed l.sfges

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x72b	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfges rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as signed integers. If the contents of the first register are greater than or equal to the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] >= rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] >= rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfgesi Set Flag if Greater or Equal Than Immediate Signed l.sfgesi

31 21	20 16	15 0
opcode 0x5eb	A	I
11 bits	5 bits	16bits

Format:

```
l.sfgesi rA,I
```

Description:

The contents of general-purpose register rA and the sign-extended immediate value are compared as signed integers. If the contents of the first register are greater than or equal to the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] >= exts(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] >= exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfgeu Set Flag if Greater or Equal Than Unsigned l.sfgeu

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x723	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfgeu rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as unsigned integers. If the contents of the first register are greater than or equal to the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] >= rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] >= rB[63:0]
```

Exceptions:

None

Instruction Class
ORBIS32 I

l.sfgeui Set Flag if Greater or Equal Than Immediate Unsigned l.sfgeui

31 21	20 . . . 16	15 0
opcode 0x5e3	A	I
11 bits	5 bits	16bits

Format:

```
l.sfgeui rA,I
```

Description:

The contents of general-purpose register rA and the zero-extended immediate value are compared as unsigned integers. If the contents of the first register are greater than or equal to the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] >= extz(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] >= extz(Immediate)
```

Exceptions:

```
None
```

l.sfgts Set Flag if Greater Than Signed l.sfgts

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x72a	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfgts rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as signed integers. If the contents of the first register are greater than the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] > rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] > rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfgtsi Set Flag if Greater Than Immediate Signed l.sfgtsi

31 21	20 . . . 16	15 0
opcode 0x5ea	A	I
11 bits	5 bits	16bits

Format:

```
l.sfgtsi rA,I
```

Description:

The contents of general-purpose register rA and the sign-extended immediate value are compared as signed integers. If the contents of the first register are greater than the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] > exts(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] > exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfgtu Set Flag if Greater Than Unsigned l.sfgtu

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x722	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfgtu rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as unsigned integers. If the contents of the first register are greater than the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] > rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] > rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfgtui Set Flag if Greater Than Immediate Unsigned l.sfgtui

31 21	20 . . . 16	15 0
opcode 0x5e2	A	I
11 bits	5 bits	16bits

Format:

```
l.sfgtui rA,I
```

Description:

The contents of general-purpose register rA and the zero-extended immediate value are compared as unsigned integers. If the contents of the first register are greater than the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] > extz(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] > extz(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfles Set Flag if Less or Equal Than Signed l.sfles

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x72d	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfles rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as signed integers. If the contents of the first register are less than or equal to the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] <= rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] <= rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sflesi Set Flag if Less or Equal Than Immediate Signed l.sflesi

31 21	20 . . . 16	15 0
opcode 0x5ed	A	I
11 bits	5 bits	16bits

Format:

```
l.sflesi rA,I
```

Description:

The contents of general-purpose register rA and the sign-extended immediate value are compared as signed integers. If the contents of the first register are less than or equal to the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] <= exts(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] <= exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfleu **Set Flag if Less or Equal Than Unsigned** **l.sfleu**

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x725	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfleu rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as unsigned integers. If the contents of the first register are less than or equal to the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] <= rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] <= rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfleui Set Flag if Less or Equal Than Immediate Unsigned l.sfleui

31 21	20 . . . 16	15 0
opcode 0x5e5	A	I
11 bits	5 bits	16bits

Format:

```
l.sfleui rA,I
```

Description:

The contents of general-purpose register rA and the zero-extended immediate value are compared as unsigned integers. If the contents of the first register are less than or equal to the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] <= extz(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] <= extz(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sflts Set Flag if Less Than Signed l.sflts

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x72c	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sflts rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as signed integers. If the contents of the first register are less than the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] < rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] < rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfltsi Set Flag if Less Than Immediate Signed l.sfltsi

31 21	20 . . . 16	15 0
opcode 0x5ec	A	I
11 bits	5 bits	16bits

Format:

```
l.sfltsi rA,I
```

Description:

The contents of general-purpose register rA and the sign-extended immediate value are compared as signed integers. If the contents of the first register are less than the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] < exts(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] < exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfltu Set Flag if Less Than Unsigned l.sfltu

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x724	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfltu rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared as unsigned integers. If the contents of the first register are less than the contents of the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] < rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] < rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sfltui Set Flag if Less Than Immediate Unsigned l.sfltui

31 21	20 . . . 16	15 0
opcode 0x5e4	A	I
11 bits	5 bits	16bits

Format:

```
l.sfltui rA,I
```

Description:

The contents of general-purpose register rA and the zero-extended immediate value are compared as unsigned integers. If the contents of the first register are less than the immediate value the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] < extz(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] < extz(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sfne　　Set Flag if Not Equal　　l.sfne

31 21	20 . . . 16	15 . . . 11	10 0
opcode 0x721	A	B	reserved
11 bits	5 bits	5 bits	11bits

Format:

```
l.sfne rA,rB
```

Description:

The contents of general-purpose registers rA and rB are compared. If the contents are not equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] != rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[63:0] != rB[63:0]
```

Exceptions:

None

Instruction Class
ORBIS32 I

l.sfnei **Set Flag if Not Equal Immediate** **l.sfnei**

31 21	20 . . . 16	15 0
opcode 0x5e1	A	I
11 bits	5 bits	16bits

Format:

```
l.sfnei rA,I
```

Description:

The contents of general-purpose register rA and the sign-extended immediate value are compared. If the two values are not equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] != exts(Immediate)
```

64-bit Implementation:

```
SR[F] <- rA[63:0] != exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 II

l.sh **Store Half Word** **l.sh**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 0
opcode 0x37	I	A	B	I
6 bits	5 bits	5 bits	5 bits	11bits

Format:

```
l.sh I(rA),rB
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The low-order 16 bits of general-purpose register rB are stored to memory location addressed by EA.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
(EA)[15:0] <- rB[15:0]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
(EA)[15:0] <- rB[15:0]
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS32 I

l.sll **Shift Left Logical** **l.sll**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x8
6 bits	5 bits	5 bits	5 bits	1 bits	4 bits	2 bits	4bits

Format:

```
l.sll rD,rA,rB
```

Description:

General-purpose register rB specifies the number of bit positions; the contents of general-purpose register rA are shifted left, inserting zeros into the low-order bits. The result is written into general-purpose rD. In 32-bit implementations bit 5 of rB is ignored.

32-bit Implementation:

```
rD[31:rB[4:0]] <- rA[31-rB[4:0]:0]
rD[rB[4:0]-1:0] <- 0
```

64-bit Implementation:

```
rD[63:rB[5:0]] <- rA[63-rB[5:0]:0]
rD[rB[5:0]-1:0] <- 0
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.slli Shift Left Logical with Immediate l.slli

31 26	25 . . . 21	20 . . . 16	15 8	7 6	5 0
opcode 0x2e	D	A	reserved	opcode 0x0	L
6 bits	5 bits	5 bits	8 bits	2 bits	6bits

Format:

```
l.slli rD,rA,L
```

Description:

The immediate value specifies the number of bit positions; the contents of general-purpose register rA are shifted left, inserting zeros into the low-order bits. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of immediate is ignored.

32-bit Implementation:

```
rD[31:L] <- rA[31-L:0]
rD[L-1:0] <- 0
```

64-bit Implementation:

```
rD[63:L] <- rA[63-L:0]
rD[L-1:0] <- 0
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sra **Shift Right Arithmetic** **l.sra**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x2	reserved	opcode 0x8
6 bits	5 bits	5 bits	5 bits	1 bits	4 bits	2 bits	4bits

Format:

```
l.sra rD,rA,rB
```

Description:

General-purpose register rB specifies the number of bit positions; the contents of general-purpose register rA are shifted right, sign-extending the high-order bits. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of rB is ignored.

32-bit Implementation:

```
rD[31-rB[4:0]:0] <- rA[31:rB[4:0]]
rD[31:32-rB[4:0]] <- rA[31]
```

64-bit Implementation:

```
rD[63-rB[5:0]:0] <- rA[63:rB[5:0]]
rD[63:64-rB[5:0]] <- rA[63]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.srai Shift Right Arithmetic with Immediate l.srai

31 26	25 . . . 21	20 . . . 16	15 8	7 6	5 0
opcode 0x2e	D	A	reserved	opcode 0x2	L
6 bits	5 bits	5 bits	8 bits	2 bits	6bits

Format:

```
l.srai rD,rA,L
```

Description:

The 6-bit immediate value specifies the number of bit positions; the contents of general-purpose register rA are shifted right, sign-extending the high-order bits. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of immediate is ignored.

32-bit Implementation:

```
rD[31-L:0] <- rA[31:L]
rD[31:32-L] <- rA[31]
```

64-bit Implementation:

```
rD[63-L:0] <- rA[63:L]
rD[63:64-L] <- rA[63]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.srl **Shift Right Logical** **l.srl**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 . . 6	5 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x1	reserved	opcode 0x8
6 bits	5 bits	5 bits	5 bits	1 bits	4 bits	2 bits	4bits

Format:

```
l.srl rD,rA,rB
```

Description:

General-purpose register rB specifies the number of bit positions; the contents of general-purpose register rA are shifted right, inserting zeros into the high-order bits. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of rB is ignored.

32-bit Implementation:

```
rD[31-rB[4:0]:0] <- rA[31:rB[4:0]]
rD[31:32-rB[4:0]] <- 0
```

64-bit Implementation:

```
rD[63-rB[5:0]:0] <- rA[63:rB[5:0]]
rD[63:64-rB[5:0]] <- 0
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.srli **Shift Right Logical with Immediate** **l.srli**

31 26	25 . . . 21	20 . . . 16	15 8	7 6	5 0
opcode 0x2e	D	A	reserved	opcode 0x1	L
6 bits	5 bits	5 bits	8 bits	2 bits	6bits

Format:

```
l.srli rD,rA,L
```

Description:

The 6-bit immediate value specifies the number of bit positions; the contents of general-purpose register rA are shifted right, inserting zeros into the high-order bits. The result is written into general-purpose register rD. In 32-bit implementations bit 5 of immediate is ignored.

32-bit Implementation:

```
rD[31-L:0] <- rA[31:L]
rD[31:32-L] <- 0
```

64-bit Implementation:

```
rD[63-L:0] <- rA[63:L]
rD[63:64-L] <- 0
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.sub Subtract Signed l.sub

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x2
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.sub rD,rA,rB
```

Description:

The contents of general-purpose register rB are subtracted from the contents of general-purpose register rA to form the result. The result is placed into general-purpose register rD. This isntruction does not change carry SR[CY] flag.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] - rB[31:0]
SR[CY] <- carry
SR[OV] <- overflow
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] - rB[63:0]
SR[CY] <- carry
SR[OV] <- overflow
```

Exceptions:

```
Range Exception
```

Instruction Class
ORBIS32 I

l.sw Store Single Word l.sw

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 0
opcode 0x35	I	A	B	I
6 bits	5 bits	5 bits	5 bits	11bits

Format:

```
l.sw I(rA),rB
```

Description:

The offset is sign-extended and added to the contents of general-purpose register rA. The sum represents an effective address. The low-order 32 bits of general-purpose register rB are stored to memory location addressed by EA.

32-bit Implementation:

```
EA <- exts(Immediate) + rA[31:0]
(EA)[31:0] <- rB[31:0]
```

64-bit Implementation:

```
EA <- exts(Immediate) + rA[63:0]
(EA)[31:0] <- rB[31:0]
```

Exceptions:

```
TLB miss
Page fault
Bus error
Alignment
```

Instruction Class
ORBIS32 I

l.sys	System Call	l.sys

31 16	15 0
opcode 0x2000	K
16 bits	16bits

Format:

```
l.sys K
```

Description:

Execution of the system call instruction results in the system call exception. The system calls exception is a request to the operating system to provide operating system services. The immediate value can be used to specify which system service is requested, alternatively a GPR defined by the ABI can be used to specify system service.

32-bit Implementation:

```
system-call-exception(K)
```

64-bit Implementation:

```
system-call-exception(K)
```

Exceptions:

```
System Call
```

Instruction Class
ORBIS32 I

l.trap **Trap** **l.trap**

31 16	15 0
opcode 0x2100	K
16 bits	16bits

Format:

```
l.trap K
```

Description:

Execution of trap instruction results in the trap exception if specified bit in SR is set. Trap exception is a request to the operating system or to the debug facility to execute certain debug services. Immediate value is used to select which SR bit is tested by trap instruction.

32-bit Implementation:

```
if SR[K] = 1 then trap-exception()
```

64-bit Implementation:

```
if SR[K] = 1 then trap-exception()
```

Exceptions:

```
Trap exception
```

Instruction Class
ORBIS32 II

l.xor **Exclusive Or** **l.xor**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10	9 8	7 . . 4	3 . . 0
opcode 0x38	D	A	B	reserved	opcode 0x0	reserved	opcode 0x5
6 bits	5 bits	5 bits	5 bits	1 bits	2 bits	4 bits	4bits

Format:

```
l.xor rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical XOR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] XOR rB[31:0]
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] XOR rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

l.xori Exclusive Or with Immediate Half Word l.xori

31 26	25 . . . 21	20 . . . 16	15 0
opcode 0x2b	D	A	I
6 bits	5 bits	5 bits	16bits

Format:

```
l.xori rD,rA,I
```

Description:

The immediate value is sign-extended and combined with the contents of general-purpose register rA in a bit-wise logical XOR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] XOR exts(Immediate)
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] XOR exts(Immediate)
```

Exceptions:

```
None
```

Instruction Class
ORBIS32 I

lf.add.d — Add Floating-Point Double-Precision — lf.add.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x10
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.add.d rD,rA,rB
```

Description:

The contents of general-purpose register rA are added to the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] + rB[63:0]
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX64 I

lf.add.s **Add Floating-Point Single-Precision** **lf.add.s**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x0
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.add.s rD,rA,rB
```

Description:

The contents of general-purpose register rA are added to the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] + rB[31:0]
```

64-bit Implementation:

```
rD[31:0] <- rA[31:0] + rB[31:0]
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 I

lf.cust1.d **Reserved for ORFPX64 Custom Instructions** **lf.cust1.d**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 . . 4	3 . . 0
opcode 0x32	reserved	A	B	reserved	opcode 0xe	reserved
6 bits	5 bits	5 bits	5 bits	3 bits	4 bits	4bits

Format:

```
lf.cust1.d rA,rB
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but instead by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

lf.cust1.s Reserved for ORFPX32 Custom Instructions lf.cust1.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 . . 4	3 . . 0
opcode 0x32	reserved	A	B	reserved	opcode 0xd	reserved
6 bits	5 bits	5 bits	5 bits	3 bits	4 bits	4bits

Format:

```
lf.cust1.s rA,rB
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but instead by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

lf.div.d **Divide Floating-Point Double-Precision** **lf.div.d**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x13
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.div.d rD,rA,rB
```

Description:

The contents of general-purpose register rA are divided by the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] / rB[63:0]
```

Exceptions:

```
Floating Point
```

lf.div.s **Divide Floating-Point Single-Precision** **lf.div.s**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x3
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.div.s rD,rA,rB
```

Description:

The contents of general-purpose register rA are divided by the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] / rB[31:0]
```

64-bit Implementation:

```
rD[31:0] <- rA[31:0] / rB[31:0]
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 II

lf.ftoi.d **Floating-Point Double-Precision To Integer** **lf.ftoi.d**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	opcode 0x0	reserved	opcode 0x15
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.ftoi.d rD,rA
```

Description:

The contents of general-purpose register rA are converted to an integer and stored in general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- ftoi(rA[63:0])
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX64 I

lf.ftoi.s Floating-Point Single-Precision To Integer lf.ftoi.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	opcode 0x0	reserved	opcode 0x5
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.ftoi.s rD,rA
```

Description:

The contents of general-purpose register rA are converted to an integer and stored into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- ftoi(rA[31:0])
```

64-bit Implementation:

```
rD[31:0] <- ftoi(rA[31:0])
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 I

lf.itof.d Integer To Floating-Point Double-Precision lf.itof.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	opcode 0x0	reserved	opcode 0x14
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.itof.d rD,rA
```

Description:

The contents of general-purpose register rA are converted to a double-precision floating-point number and stored in general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- itof(rA[63:0])
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX64 I

lf.itof.s Integer To Floating-Point Single-Precision lf.itof.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	opcode 0x0	reserved	opcode 0x4
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.itof.s rD,rA
```

Description:

The contents of general-purpose register rA are converted to a single-precision floating-point number and stored into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- itof(rA[31:0])
```

64-bit Implementation:

```
rD[31:0] <- itof(rA[31:0])
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 I

lf.madd.d Multiply and Add Floating-Point Double-Precision lf.madd.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x17
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.madd.d rD,rA,rB
```

Description:

The contents of general-purpose register rA are multiplied by the contents of general-purpose register rB, and added to special-purpose register FPMADDLO/FPMADDHI.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
FPMADDHI[31:0]FPMADDLO[31:0] <- rA[63:0] * rB[63:0] + FPMADDHI[31:0]FPMADDLO[31:0]
```

Exceptions:

```
Floating Point
```

lf.madd.s Multiply and Add Floating-Point Single-Precision lf.madd.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x7
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.madd.s rD,rA,rB
```

Description:

The contents of general-purpose register rA are multiplied by the contents of general-purpose register rB, and added to special-purpose register FPMADDLO/FPMADDHI.

32-bit Implementation:

```
FPMADDHI[31:0]FPMADDLO[31:0] <- rA[31:0] * rB[31:0] + FPMADDHI[31:0]FPMADDLO[31:0]
```

64-bit Implementation:

```
FPMADDHI[31:0]FPMADDLO[31:0] <- rA[31:0] * rB[31:0] + FPMADDHI[31:0]FPMADDLO[31:0]
FPMADDHI <- 0
FPMADDLO <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 II

lf.mul.d Multiply Floating-Point Double-Precision lf.mul.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x12
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.mul.d rD,rA,rB
```

Description:

The contents of general-purpose register rA are multiplied by the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] * rB[63:0]
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX64 I

lf.mul.s Multiply Floating-Point Single-Precision lf.mul.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x2
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.mul.s rD,rA,rB
```

Description:

The contents of general-purpose register rA are multiplied by the contents of general-purpose register rB to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] * rB[31:0]
```

64-bit Implementation:

```
rD[31:0] <- rA[31:0] * rB[31:0]
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 I

lf.rem.d Remainder Floating-Point Double-Precision lf.rem.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x16
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.rem.d rD,rA,rB
```

Description:

The contents of general-purpose register rA are divided by the contents of general-purpose register rB, and remainder is used as the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] % rB[63:0]
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX64 II

lf.rem.s Remainder Floating-Point Single-Precision lf.rem.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x6
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.rem.s rD,rA,rB
```

Description:

The contents of general-purpose register rA are divided by the contents of general-purpose register rB, and remainder is used as the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] % rB[31:0]
```

64-bit Implementation:

```
rD[31:0] <- rA[31:0] % rB[31:0]
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

lf.sfeq.d Set Flag if Equal Floating-Point Double-Precision lf.sfeq.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x18
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfeq.d rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the two registers are equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
SR[F] <- rA[63:0] == rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX64 I

lf.sfeq.s Set Flag if Equal Floating-Point Single-Precision lf.sfeq.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x8
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfeq.s rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the two registers are equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] == rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[31:0] == rB[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX32 I

lf.sfge.d Set Flag if Greater or Equal Than Floating-Point Double-Precision lf.sfge.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x1b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfge.d rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is greater than or equal to the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
SR[F] <- rA[63:0] >= rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX64 I

lf.sfge.s Set Flag if Greater or Equal Than Floating-Point Single-Precision lf.sfge.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0xb
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfge.s rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is greater than or equal to the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] >= rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[31:0] >= rB[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX32 I

lf.sfgt.d Set Flag if Greater Than Floating-Point Double-Precision lf.sfgt.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x1a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfgt.d rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is greater than the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
SR[F] <- rA[63:0] > rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX64 I

lf.sfgt.s Set Flag if Greater Than Floating-Point Single-Precision lf.sfgt.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0xa
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfgt.s rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is greater than the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] > rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[31:0] > rB[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX32 I

lf.sfle.d Set Flag if Less or Equal Than Floating-Point Double-Precision lf.sfle.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x1d
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfle.d rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is less than or equal to the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
SR[F] <- rA[363:0] <= rB[63:0]
```

Exceptions:

```
None
```

lf.sfle.s Set Flag if Less or Equal Than Floating-Point Single-Precision lf.sfle.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0xd
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfle.s rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is less than or equal to the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] <= rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[31:0] <= rB[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX32 I

lf.sflt.d Set Flag if Less Than Floating-Point Double-Precision lf.sflt.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x1c
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sflt.d rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is less than the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
SR[F] <- rA[63:0] < rB[63:0]
```

Exceptions:

```
None
```

lf.sflt.s Set Flag if Less Than Floating-Point Single-Precision lf.sflt.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0xc
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sflt.s rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the first register is less than the second register, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] < rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[31:0] < rB[31:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX32 I

lf.sfne.d Set Flag if Not Equal Floating-Point Double-Precision lf.sfne.d

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x19
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfne.d rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the two registers are not equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
SR[F] <- rA[63:0] != rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORFPX64 I

lf.sfne.s Set Flag if Not Equal Floating-Point Single-Precision lf.sfne.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	reserved	A	B	reserved	opcode 0x9
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sfne.s rA,rB
```

Description:

The contents of general-purpose register rA and the contents of general-purpose register rB are compared. If the two registers are not equal, the compare flag is set; otherwise the compare flag is cleared.

32-bit Implementation:

```
SR[F] <- rA[31:0] != rB[31:0]
```

64-bit Implementation:

```
SR[F] <- rA[31:0] != rB[31:0]
```

Exceptions:

```
None
```

lf.sub.d **Subtract Floating-Point Double-Precision** **lf.sub.d**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x11
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sub.d rD,rA,rB
```

Description:

The contents of general-purpose register rB are subtracted from the contents of general-purpose register rA to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] - rB[63:0]
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX64 I

lf.sub.s Subtract Floating-Point Single-Precision lf.sub.s

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0x32	D	A	B	reserved	opcode 0x1
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lf.sub.s rD,rA,rB
```

Description:

The contents of general-purpose register rB are subtracted from the contents of general-purpose register rA to form the result. The result is placed into general-purpose register rD.

32-bit Implementation:

```
rD[31:0] <- rA[31:0] - rB[31:0]
```

64-bit Implementation:

```
rD[31:0] <- rA[31:0] - rB[31:0]
rD[63:32] <- 0
```

Exceptions:

```
Floating Point
```

Instruction Class
ORFPX32 I

lv.add.b — Vector Byte Elements Add Signed — lv.add.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x30
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.add.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rA are added to the byte elements of general-purpose register rB to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] + rB[7:0]
rD[15:8] <- rA[15:8] + rB[15:8]
rD[23:16] <- rA[23:16] + rB[23:16]
rD[31:24] <- rA[31:24] + rB[31:24]
rD[39:32] <- rA[39:32] + rB[39:32]
rD[47:40] <- rA[47:40] + rB[47:40]
rD[55:48] <- rA[55:48] + rB[55:48]
rD[63:56] <- rA[63:56] + rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.add.h **Vector Half-Word Elements Add Signed** **lv.add.h**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x31
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.add.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rA are added to the half-word elements of general-purpose register rB to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] + rB[15:0]
rD[31:16] <- rA[31:16] + rB[31:16]
rD[47:32] <- rA[47:32] + rB[47:32]
rD[63:48] <- rA[63:48] + rB[63:48]
```

Exceptions:

```
None
```

lv.adds.b Vector Byte Elements Add Signed Saturated lv.adds.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x32
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.adds.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rA are added to the byte elements of general-purpose register rB to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- sat8s(rA[7:0] + rB[7:0])
rD[15:8] <- sat8s(rA[15:8] + rB[15:8])
rD[23:16] <- sat8s(rA[23:16] + rB[23:16])
rD[31:24] <- sat8s(rA[31:24] + rB[31:24])
rD[39:32] <- sat8s(rA[39:32] + rB[39:32])
rD[47:40] <- sat8s(rA[47:40] + rB[47:40])
rD[55:48] <- sat8s(rA[55:48] + rB[55:48])
rD[63:56] <- sat8s(rA[63:56] + rB[63:56])
```

Exceptions:

```
None
```

lv.adds.h   Vector Half-Word Elements Add Signed Saturated   lv.adds.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x33
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.adds.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rA are added to the half-word elements of general-purpose register rB to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat16s(rA[15:0] + rB[15:0])
rD[31:16] <- sat16s(rA[31:16] + rB[31:16])
rD[47:32] <- sat16s(rA[47:32] + rB[47:32])
rD[63:48] <- sat16s(rA[63:48] + rB[63:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.addu.b — Vector Byte Elements Add Unsigned — lv.addu.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x34
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.addu.b rD,rA,rB
```

Description:

The unsigned byte elements of general-purpose register rA are added to the unsigned byte elements of general-purpose register rB to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] + rB[7:0]
rD[15:8] <- rA[15:8] + rB[15:8]
rD[23:16] <- rA[23:16] + rB[23:16]
rD[31:24] <- rA[31:24] + rB[31:24]
rD[39:32] <- rA[39:32] + rB[39:32]
rD[47:40] <- rA[47:40] + rB[47:40]
rD[55:48] <- rA[55:48] + rB[55:48]
rD[63:56] <- rA[63:56] + rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.addu.h — Vector Half-Word Elements Add Unsigned — lv.addu.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x35
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.addu.h rD,rA,rB
```

Description:

The unsigned half-word elements of general-purpose register rA are added to the unsigned half-word elements of general-purpose register rB to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] + rB[15:0]
rD[31:16] <- rA[31:16] + rB[31:16]
rD[47:32] <- rA[47:32] + rB[47:32]
rD[63:48] <- rA[63:48] + rB[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.addus.b Vector Byte Elements Add Unsigned Saturated lv.addus.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x36
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.addus.b rD,rA,rB
```

Description:

The unsigned byte elements of general-purpose register rA are added to the unsigned byte elements of general-purpose register rB to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- sat8u(rA[7:0] + rB[7:0])
rD[15:8] <- sat8u(rA[15:8] + rB[15:8])
rD[23:16] <- sat8u(rA[23:16] + rB[23:16])
rD[31:24] <- sat8u(rA[31:24] + rB[31:24])
rD[39:32] <- sat8u(rA[39:32] + rB[39:32])
rD[47:40] <- sat8u(rA[47:40] + rB[47:40])
rD[55:48] <- sat8u(rA[55:48] + rB[55:48])
rD[63:56] <- sat8u(rA[63:56] + rB[63:56])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.addus.h Vector Half-Word Elements Add Unsigned Saturated lv.addus.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x37
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.addus.h rD,rA,rB
```

Description:

The unsigned half-word elements of general-purpose register rA are added to the unsigned half-word elements of general-purpose register rB to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat16s(rA[15:0] + rB[15:0])
rD[31:16] <- sat16s(rA[31:16] + rB[31:16])
rD[47:32] <- sat16s(rA[47:32] + rB[47:32])
rD[63:48] <- sat16s(rA[63:48] + rB[63:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_eq.b Vector Byte Elements All Equal lv.all_eq.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x10
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_eq.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if all corresponding elements are equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] == rB[7:0]
   rA[15:8] == rB[15:8] &&
   rA[23:16] == rB[23:16] &&
   rA[31:24] == rB[31:24] &&
   rA[39:32] == rB[39:32] &&
   rA[47:40] == rB[47:40] &&
   rA[55:48] == rB[55:48] &&
   rA[63:56] == rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_eq.h Vector Half-Word Elements All Equal lv.all_eq.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x11
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_eq.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if all corresponding elements are equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] == rB[15:0] &&
   rA[31:16] == rB[31:16] &&
   rA[47:32] == rB[47:32] &&
   rA[63:48] == rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_ge.b Vector Byte Elements All Greater Than or Equal To lv.all_ge.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x12
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_ge.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if all elements of rA are greater than or equal to the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] >= rB[7:0] &&
   rA[15:8] >= rB[15:8] &&
   rA[23:16] >= rB[23:16] &&
   rA[31:24] >= rB[31:24] &&
   rA[39:32] >= rB[39:32] &&
   rA[47:40] >= rB[47:40] &&
   rA[55:48] >= rB[55:48] &&
   rA[63:56] >= rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_ge.h Vector Half-Word Elements All Greater Than or Equal To lv.all_ge.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x13
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_ge.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if all elements of rA are greater than or equal to the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] >= rB[15:0] &&
   rA[31:16] >= rB[31:16] &&
   rA[47:32] >= rB[47:32] &&
   rA[63:48] >= rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.all_gt.b   Vector Byte Elements All Greater Than   lv.all_gt.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x14
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_gt.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if all elements of rA are greater than the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] > rB[7:0] &&
   rA[15:8] > rB[15:8] &&
   rA[23:16] > rB[23:16] &&
   rA[31:24] > rB[31:24] &&
   rA[39:32] > rB[39:32] &&
   rA[47:40] > rB[47:40] &&
   rA[55:48] > rB[55:48] &&
   rA[63:56] > rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_gt.h Vector Half-Word Elements All Greater Than lv.all_gt.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x15
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_gt.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if all elements of rA are greater than the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] > rB[15:0] &&
   rA[31:16] > rB[31:16] &&
   rA[47:32] > rB[47:32] &&
   rA[63:48] > rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_le.b Vector Byte Elements All Less Than or Equal To lv.all_le.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x16
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_le.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if all elements of rA are less than or equal to the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] <= rB[7:0] &&
   rA[15:8] <= rB[15:8] &&
   rA[23:16] <= rB[23:16] &&
   rA[31:24] <= rB[31:24] &&
   rA[39:32] <= rB[39:32] &&
   rA[47:40] <= rB[47:40] &&
   rA[55:48] <= rB[55:48] &&
   rA[63:56] <= rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_le.h Vector Half-Word Elements All Less Than or Equal To lv.all_le.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x17
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_le.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if all elements of rA are less than or equal to the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] <= rB[15:0] &&
   rA[31:16] <= rB[31:16] &&
   rA[47:32] <= rB[47:32] &&
   rA[63:48] <= rB[63:48]rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.all_lt.b Vector Byte Elements All Less Than lv.all_lt.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x18
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_lt.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if all elements of rA are less than the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] < rB[7:0] &&
   rA[15:8] < rB[15:8] &&
   rA[23:16] < rB[23:16] &&
   rA[31:24] < rB[31:24] &&
   rA[39:32] < rB[39:32] &&
   rA[47:40] < rB[47:40] &&
   rA[55:48] < rB[55:48] &&
   rA[63:56] < rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_lt.h Vector Half-Word Elements All Less Than lv.all_lt.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x19
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_lt.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if all elements of rA are less than the elements of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] < rB[15:0] &&
   rA[31:16] < rB[31:16] &&
   rA[47:32] < rB[47:32] &&
   rA[63:48] < rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.all_ne.b Vector Byte Elements All Not Equal lv.all_ne.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x1a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_ne.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if all corresponding elements are not equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] != rB[7:0] &&
   rA[15:8] != rB[15:8] &&
   rA[23:16] != rB[23:16] &&
   rA[31:24] != rB[31:24] &&
   rA[39:32] != rB[39:32] &&
   rA[47:40] != rB[47:40] &&
   rA[55:48] != rB[55:48] &&
   rA[63:56] != rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.all_ne.h Vector Half-Word Elements All Not Equal lv.all_ne.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x1b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.all_ne.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if all corresponding elements are not equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] != rB[15:0] &&
   rA[31:16] != rB[31:16] &&
   rA[47:32] != rB[47:32] &&
   rA[63:48] != rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.and **Vector And** **lv.and**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x38
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.and rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical AND operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] AND rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_eq.b **Vector Byte Elements Any Equal** **lv.any_eq.b**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x20
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_eq.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if any two corresponding elements are equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] == rB[7:0] ||
   rA[15:8] == rB[15:8] ||
   rA[23:16] == rB[23:16] ||
   rA[31:24] == rB[31:24] ||
   rA[39:32] == rB[39:32] ||
   rA[47:40] == rB[47:40] ||
   rA[55:48] == rB[55:48] ||
   rA[63:56] == rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_eq.h Vector Half-Word Elements Any Equal lv.any_eq.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x21
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_eq.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if any two corresponding elements are equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] == rB[15:0] ||
   rA[31:16] == rB[31:16] ||
   rA[47:32] == rB[47:32] ||
   rA[63:48] == rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.any_ge.b Vector Byte Elements Any Greater Than or Equal To lv.any_ge.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x22
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_ge.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if any element of rA is greater than or equal to the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] >= rB[7:0] ||
   rA[15:8] >= rB[15:8] ||
   rA[23:16] >= rB[23:16] ||
   rA[31:24] >= rB[31:24] ||
   rA[39:32] >= rB[39:32] ||
   rA[47:40] >= rB[47:40] ||
   rA[55:48] >= rB[55:48] ||
   rA[63:56] >= rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.any_ge.h Vector Half-Word Elements Any Greater Than or Equal To lv.any_ge.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x23
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_ge.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if any element of rA is greater than or equal to the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] >= rB[15:0] ||
   rA[31:16] >= rB[31:16] ||
   rA[47:32] >= rB[47:32] ||
   rA[63:48] >= rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.any_gt.b Vector Byte Elements Any Greater Than lv.any_gt.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x24
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_gt.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if any element of rA is greater than the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] > rB[7:0] ||
   rA[15:8] > rB[15:8] ||
   rA[23:16] > rB[23:16] ||
   rA[31:24] > rB[31:24] ||
   rA[39:32] > rB[39:32] ||
   rA[47:40] > rB[47:40] ||
   rA[55:48] > rB[55:48] ||
   rA[63:56] > rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_gt.h Vector Half-Word Elements Any Greater Than lv.any_gt.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x25
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_gt.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if any element of rA is greater than the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] > rB[15:0] ||
   rA[31:16] > rB[31:16] ||
   rA[47:32] > rB[47:32] ||
   rA[63:48] > rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_le.b Vector Byte Elements Any Less Than or Equal To lv.any_le.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x26
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_le.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if any element of rA is less than or equal to the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] <= rB[7:0] ||
   rA[15:8] <= rB[15:8] ||
   rA[23:16] <= rB[23:16] ||
   rA[31:24] <= rB[31:24] ||
   rA[39:32] <= rB[39:32] ||
   rA[47:40] <= rB[47:40] ||
   rA[55:48] <= rB[55:48] ||
   rA[63:56] <= rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_le.h Vector Half-Word Elements Any Less Than or Equal To lv.any_le.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x27
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_le.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if any element of rA is less than or equal to the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] ,= rB[15:0] ||
   rA[31:16] <= rB[31:16] ||
   rA[47:32] <= rB[47:32] ||
   rA[63:48] <= rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_lt.b — Vector Byte Elements Any Less Than — lv.any_lt.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x28
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_lt.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if any element of rA is less than the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] < rB[7:0] ||
   rA[15:8] < rB[15:8] ||
   rA[23:16] < rB[23:16] ||
   rA[31:24] < rB[31:24] ||
   rA[39:32] < rB[39:32] ||
   rA[47:40] < rB[47:40] ||
   rA[55:48] < rB[55:48] ||
   rA[63:56] < rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.any_lt.h Vector Half-Word Elements Any Less Than lv.any_lt.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x29
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_lt.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if any element of rA is less than the corresponding element of rB; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] < rB[15:0] ||
   rA[31:16] < rB[31:16] ||
   rA[47:32] < rB[47:32] ||
   rA[63:48] < rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

lv.any_ne.b — Vector Byte Elements Any Not Equal — lv.any_ne.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x2a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_ne.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. The compare flag is set if any two corresponding elements are not equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[7:0] != rB[7:0] ||
   rA[15:8] != rB[15:8] ||
   rA[23:16] != rB[23:16] ||
   rA[31:24] != rB[31:24] ||
   rA[39:32] != rB[39:32] ||
   rA[47:40] != rB[47:40] ||
   rA[55:48] != rB[55:48] ||
   rA[63:56] != rB[63:56]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.any_ne.h Vector Half-Word Elements Any Not Equal lv.any_ne.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x2b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.any_ne.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. The compare flag is set if any two corresponding elements are not equal; otherwise the compare flag is cleared.
The compare flag is replicated into all bit positions of general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
flag <- rA[15:0] != rB[15:0] ||
   rA[31:16] != rB[31:16] ||
   rA[47:32] != rB[47:32] ||
   rA[63:48] != rB[63:48]
rD[63:0] <- repl(flag)
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.avg.b **Vector Byte Elements Average** **lv.avg.b**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x39
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.avg.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rA are added to the byte elements of general-purpose register rB, and the sum is shifted right by one to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- (rA[7:0] + rB[7:0]) » 1
rD[15:8] <- (rA[15:8] + rB[15:8]) » 1
rD[23:16] <- (rA[23:16] + rB[23:16]) » 1
rD[31:24] <- (rA[31:24] + rB[31:24]) » 1
rD[39:32] <- (rA[39:32] + rB[39:32]) » 1
rD[47:40] <- (rA[47:40] + rB[47:40]) » 1
rD[55:48] <- (rA[55:48] + rB[55:48]) » 1
rD[63:56] <- (rA[63:56] + rB[63:56]) » 1
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.avg.h Vector Half-Word Elements Average lv.avg.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x3a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.avg.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rA are added to the half-word elements of general-purpose register rB, and the sum is shifted right by one to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- (rA[15:0] + rB[15:0]) » 1
rD[31:16] <- (rA[31:16] + rB[31:16]) » 1
rD[47:32] <- (rA[47:32] + rB[47:32]) » 1
rD[63:48] <- (rA[63:48] + rB[63:48]) » 1
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_eq.b **Vector Byte Elements Compare Equal** **lv.cmp_eq.b**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x40
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_eq.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the two corresponding compared elements are equal; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- repl(rA[7:0] == rB[7:0]
rD[15:8] <- repl(rA[15:8] == rB[15:8]
rD[23:16] <- repl(rA[23:16] == rB[23:16]
rD[31:24] <- repl(rA[31:24] == rB[31:24]
rD[39:32] <- repl(rA[39:32] == rB[39:32]
rD[47:40] <- repl(rA[47:40] == rB[47:40]
rD[55:48] <- repl(rA[55:48] == rB[55:48]
rD[63:56] <- repl(rA[63:56] == rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_eq.h Vector Half-Word Elements Compare Equal lv.cmp_eq.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x41
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_eq.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the two corresponding compared elements are equal; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- repl(rA[7:0] == rB[7:0]
rD[31:16] <- repl(rA[23:16] == rB[23:16]
rD[47:32] <- repl(rA[39:32] == rB[39:32]
rD[63:48] <- repl(rA[55:48] == rB[55:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_ge.b Vector Byte Elements Compare Greater Than or Equal To lv.cmp_ge.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x42
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_ge.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is greater than or equal to the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- repl(rA[7:0] >= rB[7:0]
rD[15:8] <- repl(rA[15:8] >= rB[15:8]
rD[23:16] <- repl(rA[23:16] >= rB[23:16]
rD[31:24] <- repl(rA[31:24] >= rB[31:24]
rD[39:32] <- repl(rA[39:32] >= rB[39:32]
rD[47:40] <- repl(rA[47:40] >= rB[47:40]
rD[55:48] <- repl(rA[55:48] >= rB[55:48]
rD[63:56] <- repl(rA[63:56] >= rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_ge.h Vector Half-Word Elements Compare Greater Than or Equal To lv.cmp_ge.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x43
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_ge.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is greater than or equal to the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- repl(rA[7:0] >= rB[7:0]
rD[31:16] <- repl(rA[23:16] >= rB[23:16]
rD[47:32] <- repl(rA[39:32] >= rB[39:32]
rD[63:48] <- repl(rA[55:48] >= rB[55:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_gt.b Vector Byte Elements Compare Greater Than lv.cmp_gt.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x44
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_gt.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is greater than the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- repl(rA[7:0] > rB[7:0]
rD[15:8] <- repl(rA[15:8] > rB[15:8]
rD[23:16] <- repl(rA[23:16] > rB[23:16]
rD[31:24] <- repl(rA[31:24] > rB[31:24]
rD[39:32] <- repl(rA[39:32] > rB[39:32]
rD[47:40] <- repl(rA[47:40] > rB[47:40]
rD[55:48] <- repl(rA[55:48] > rB[55:48]
rD[63:56] <- repl(rA[63:56] > rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_gt.h Vector Half-Word Elements Compare Greater Than lv.cmp_gt.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x45
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_gt.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is greater than the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- repl(rA[7:0] > rB[7:0]
rD[31:16] <- repl(rA[23:16] > rB[23:16]
rD[47:32] <- repl(rA[39:32] > rB[39:32]
rD[63:48] <- repl(rA[55:48] > rB[55:48]
```

Exceptions:

```
None
```

lv.cmp_le.b Vector Byte Elements Compare Less Than or Equal To lv.cmp_le.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x46
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_le.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is less than or equal to the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- repl(rA[7:0] <= rB[7:0]
rD[15:8] <- repl(rA[15:8] <= rB[15:8]
rD[23:16] <- repl(rA[23:16] <= rB[23:16]
rD[31:24] <- repl(rA[31:24] <= rB[31:24]
rD[39:32] <- repl(rA[39:32] <= rB[39:32]
rD[47:40] <- repl(rA[47:40] <= rB[47:40]
rD[55:48] <- repl(rA[55:48] <= rB[55:48]
rD[63:56] <- repl(rA[63:56] <= rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_le.h Vector Half-Word Elements Compare Less Than or Equal To lv.cmp_le.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x47
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_le.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is less than or equal to the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- repl(rA[7:0] <= rB[7:0]
rD[31:16] <- repl(rA[23:16] <= rB[23:16]
rD[47:32] <- repl(rA[39:32] <= rB[39:32]
rD[63:48] <- repl(rA[55:48] <= rB[55:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_lt.b Vector Byte Elements Compare Less Than lv.cmp_lt.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x48
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_lt.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is less than the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- repl(rA[7:0] <= rB[7:0]
rD[15:8] <- repl(rA[15:8] <= rB[15:8]
rD[23:16] <- repl(rA[23:16] <= rB[23:16]
rD[31:24] <- repl(rA[31:24] <= rB[31:24]
rD[39:32] <- repl(rA[39:32] <= rB[39:32]
rD[47:40] <- repl(rA[47:40] <= rB[47:40]
rD[55:48] <- repl(rA[55:48] <= rB[55:48]
rD[63:56] <- repl(rA[63:56] <= rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_lt.h Vector Half-Word Elements Compare Less Than lv.cmp_lt.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x49
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_lt.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the element in rA is less than the element in rB; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- repl(rA[7:0] <= rB[7:0]
rD[31:16] <- repl(rA[23:16] <= rB[23:16]
rD[47:32] <- repl(rA[39:32] <= rB[39:32]
rD[63:48] <- repl(rA[55:48] <= rB[55:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_ne.b **Vector Byte Elements Compare Not Equal** **lv.cmp_ne.b**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x4a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_ne.b rD,rA,rB
```

Description:

All byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the two corresponding compared elements are not equal; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- repl(rA[7:0] != rB[7:0])
rD[15:8] <- repl(rA[15:8] != rB[15:8])
rD[23:16] <- repl(rA[23:16] != rB[23:16])
rD[31:24] <- repl(rA[31:24] != rB[31:24])
rD[39:32] <- repl(rA[39:32] != rB[39:32])
rD[47:40] <- repl(rA[47:40] != rB[47:40])
rD[55:48] <- repl(rA[55:48] != rB[55:48])
rD[63:56] <- repl(rA[63:56] != rB[63:56])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cmp_ne.h Vector Half-Word Elements Compare Not Equal lv.cmp_ne.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x4b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.cmp_ne.h rD,rA,rB
```

Description:

All half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB. Bits of the element in general-purpose register rD are set if the two corresponding compared elements are not equal; otherwise the element bits are cleared.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- repl(rA[7:0] != rB[7:0])
rD[31:16] <- repl(rA[23:16] != rB[23:16])
rD[47:32] <- repl(rA[39:32] != rB[39:32])
rD[63:48] <- repl(rA[55:48] != rB[55:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.cust1 **Reserved for Custom Vector Instructions** **lv.cust1**

31 26	25 8	7 . . 4	3 . . 0
opcode 0xa	reserved	opcode 0xc	reserved
6 bits	18 bits	4 bits	4bits

Format:

```
lv.cust1
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but instead by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

lv.cust2 Reserved for Custom Vector Instructions lv.cust2

31 26	25 8	7 . . 4	3 . . 0
opcode 0xa	reserved	opcode 0xd	reserved
6 bits	18 bits	4 bits	4bits

Format:

```
lv.cust2
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but instead by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

lv.cust3 Reserved for Custom Vector Instructions lv.cust3

31 26	25 8	7 . . 4	3 . . 0
opcode 0xa	reserved	opcode 0xe	reserved
6 bits	18 bits	4 bits	4bits

Format:

```
lv.cust3
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but instead by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

lv.cust4 Reserved for Custom Vector Instructions lv.cust4

31 26	25 8	7 . . 4	3 . . 0
opcode 0xa	reserved	opcode 0xf	reserved
6 bits	18 bits	4 bits	4bits

Format:

```
lv.cust4
```

Description:

This fake instruction only allocates instruction set space for custom instructions. Custom instructions are those that are not defined by the architecture but instead by the implementation itself.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
N/A
```

Exceptions:

```
N/A
```

lv.madds.h Vector Half-Word Elements Multiply Add Signed Saturated lv.madds.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x54
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.madds.h rD,rA,rB
```

Description:

The signed half-word elements of general-purpose register rA are multiplied by the signed half-word elements of general-purpose register rB to form intermediate results. They are then added to the signed half-word VMAC elements to form the final results that are placed again in the VMAC registers. The intermediate result is placed into general-purpose register rD. If any of the final results exceeds the min/max value, it is saturated.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat32s(rA[15:0] * rB[15:0] + VMACLO[31:0])
rD[31:16] <- sat32s(rA[31:16] * rB[31:16] + VMACLO[63:32])
rD[47:32] <- sat32s(rA[47:32] * rB[47:32] + VMACHI[31:0])
rD[63:48] <- sat32s(rA[63:48] * rB[63:48] + VMACHI[63:32])
```

Exceptions:

```
None
```

lv.max.b Vector Byte Elements Maximum lv.max.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x55
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.max.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB, and the larger elements are selected to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] > rB[7:0] ?  rA[7:0] :  vrfB[7:0]
rD[15:8] <- rA[15:8] > rB[15:8] ?  rA[15:8] :  vrfB[15:8]
rD[23:16] <- rA[23:16] > rB[23:16] ?  rA[23:16] :  vrfB[23:16]
rD[31:24] <- rA[31:24] > rB[31:24] ?  rA[31:24] :  vrfB[31:24]
rD[39:32] <- rA[39:32] > rB[39:32] ?  rA[39:32] :  vrfB[39:32]
rD[47:40] <- rA[47:40] > rB[47:40] ?  rA[47:40] :  vrfB[47:40]
rD[55:48] <- rA[55:48] > rB[55:48] ?  rA[55:48] :  vrfB[55:48]
rD[63:56] <- rA[63:56] > rB[63:56] ?  rA[63:56] :  vrfB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.max.h **Vector Half-Word Elements Maximum** **lv.max.h**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x56
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.max.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB, and the larger elements are selected to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] > rB[15:0] ?  rA[15:0] :  vrfB[15:0]
rD[31:16] <- rA[31:16] > rB[31:16] ?  rA[31:16] :  vrfB[31:16]
rD[47:32] <- rA[47:32] > rB[47:32] ?  rA[47:32] :  vrfB[47:32]
rD[63:48] <- rA[63:48] > rB[63:48] ?  rA[63:48] :  vrfB[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.merge.b Vector Byte Elements Merge lv.merge.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x57
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.merge.b rD,rA,rB
```

Description:

The byte elements of the lower half of the general-purpose register rA are combined with the byte elements of the lower half of general-purpose register rB in such a way that the lowest element is from rB, the second element from rA, the third again from rB etc. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rB[7:0]
rD[15:8] <- rA[15:8]
rD[23:16] <- rB[23:16]
rD[31:24] <- rA[31:24]
rD[39:32] <- rB[39:32]
rD[47:40] <- rA[47:40]
rD[55:48] <- rB[55:48]
rD[63:56] <- rA[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.merge.h — Vector Half-Word Elements Merge — lv.merge.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x58
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.merge.h rD,rA,rB
```

Description:

The half-word elements of the lower half of the general-purpose register rA are combined with the half-word elements of the lower half of general-purpose register rB in such a way that the lowest element is from rB, the second element from rA, the third again from rB etc. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rB[15:0]
rD[31:16] <- rA[31:16]
rD[47:32] <- rB[47:32]
rD[63:48] <- rA[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.min.b — Vector Byte Elements Minimum — lv.min.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x59
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.min.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rA are compared to the byte elements of general-purpose register rB, and the smaller elements are selected to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] < rB[7:0] ?  rA[7:0] :  vrfB[7:0]
rD[15:8] <- rA[15:8] < rB[15:8] ?  rA[15:8] :  vrfB[15:8]
rD[23:16] <- rA[23:16] < rB[23:16] ?  rA[23:16] :  vrfB[23:16]
rD[31:24] <- rA[31:24] < rB[31:24] ?  rA[31:24] :  vrfB[31:24]
rD[39:32] <- rA[39:32] < rB[39:32] ?  rA[39:32] :  vrfB[39:32]
rD[47:40] <- rA[47:40] < rB[47:40] ?  rA[47:40] :  vrfB[47:40]
rD[55:48] <- rA[55:48] < rB[55:48] ?  rA[55:48] :  vrfB[55:48]
rD[63:56] <- rA[63:56] < rB[63:56] ?  rA[63:56] :  vrfB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.min.h   Vector Half-Word Elements Minimum   lv.min.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x5a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.min.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rA are compared to the half-word elements of general-purpose register rB, and the smaller elements are selected to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] < rB[15:0] ? rA[15:0] : vrfB[15:0]
rD[31:16] <- rA[31:16] < rB[31:16] ? rA[31:16] : vrfB[31:16]
rD[47:32] <- rA[47:32] < rB[47:32] ? rA[47:32] : vrfB[47:32]
rD[63:48] <- rA[63:48] < rB[63:48] ? rA[63:48] : vrfB[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.msubs.h Vector Half-Word Elements Multiply Subtract Signed Saturated lv.msubs.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x5b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.msubs.h rD,rA,rB
```

Description:

The signed half-word elements of general-purpose register rA are multiplied by the signed half-word elements of general-purpose register rB to form intermediate results. They are then subtracted from the signed half-word VMAC elements to form the final results that are placed again in the VMAC registers. The intermediate result is placed into general-purpose register rD. If any of the final results exceeds the min/max value, it is saturated.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat32s(VMACLO[31:0] - rA[15:0] * rB[15:0])
rD[31:16] <- sat32s(VMACLO[63:32] - rA[31:16] * rB[31:16])
rD[47:32] <- sat32s(VMACHI[31:0] - rA[47:32] * rB[47:32])
rD[63:48] <- sat32s(VMACHI[63:32] - rA[63:48] * rB[63:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.muls.h Vector Half-Word Elements Multiply Signed Saturated lv.muls.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x5c
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.muls.h rD,rA,rB
```

Description:

The signed half-word elements of general-purpose register rA are multiplied by the signed half-word elements of general-purpose register rB to form the results. The result is placed into general-purpose register rD. If any of the final results exceeds the min/max value, it is saturated.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat32s(rA[15:0] * rB[15:0])
rD[31:16] <- sat32s(rA[31:16] * rB[31:16])
rD[47:32] <- sat32s(rA[47:32] * rB[47:32])
rD[63:48] <- sat32s(rA[63:48] * rB[63:48])
```

Exceptions:

```
None
```

lv.nand **Vector Not And** **lv.nand**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x5d
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.nand rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical NAND operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] NAND rB[63:0]
```

Exceptions:

```
None
```

lv.nor **Vector Not Or** **lv.nor**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x5e
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.nor rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical NOR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] NOR rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.or	**Vector Or**	**lv.or**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x5f
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.or rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical OR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] OR rB[63:0]
```

Exceptions:

```
None
```

lv.pack.b **Vector Byte Elements Pack** **lv.pack.b**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x60
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.pack.b rD,rA,rB
```

Description:

The lower half of the byte elements of the general-purpose register rA are truncated and combined with the lower half of the byte truncated elements of the general-purpose register rB in such a way that the lowest elements are from rB, and the highest elements from rA. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[3:0] <- rB[3:0]
rD[7:4] <- rB[11:8]
rD[11:8] <- rB[19:16]
rD[15:12] <- rB[27:24]
rD[19:16] <- rB[35:32]
rD[23:20] <- rB[43:40]
rD[27:24] <- rB[51:48]
rD[31:28] <- rB[59:56]
rD[35:32] <- rA[3:0]
rD[39:36] <- rA[11:8]
rD[43:40] <- rA[19:16]
rD[47:44] <- rA[27:24]
rD[51:48] <- rA[35:32]
rD[55:52] <- rA[43:40]
rD[59:56] <- rA[51:48]
rD[63:60] <- rA[59:56]
```

Exceptions:

None

Instruction Class
ORVDX64 I

lv.pack.h Vector Half-word Elements Pack lv.pack.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x61
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.pack.h rD,rA,rB
```

Description:

The lower half of the half-word elements of the general-purpose register rA are truncated and combined with the lower half of the half-word truncated elements of the general-purpose register rB in such a way that the lowest elements are from rB, and the highest elements from rA. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rB[15:0]
rD[15:8] <- rB[31:16]
rD[23:16] <- rB[47:32]
rD[31:24] <- rB[63:48]
rD[39:32] <- rA[15:0]
rD[47:40] <- rA[31:16]
rD[55:48] <- rA[47:32]
rD[63:56] <- rA[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.packs.b Vector Byte Elements Pack Signed Saturated lv.packs.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x62
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.packs.b rD,rA,rB
```

Description:

The lower half of the signed byte elements of the general-purpose register rA are truncated and combined with the lower half of the signed byte truncated elements of the general-purpose register rB in such a way that the lowest elements are from rB, and the highest elements from rA. If any truncated element exceeds a signed 4-bit value, it is saturated. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[3:0] <- sat4s(rB[7:0]
rD[7:4] <- sat4s(rB[15:8]
rD[11:8] <- sat4s(rB[23:16]
rD[15:12] <- sat4s(rB[31:24]
rD[19:16] <- sat4s(rB[39:32]
rD[23:20] <- sat4s(rB[47:40]
rD[27:24] <- sat4s(rB[55:48]
rD[31:28] <- sat4s(rB[63:56]
rD[35:32] <- sat4s(rA[7:0]
rD[39:36] <- sat4s(rA[15:8]
rD[43:40] <- sat4s(rA[23:16]
rD[47:44] <- sat4s(rA[31:24]
rD[51:48] <- sat4s(rA[39:32]
rD[55:52] <- sat4s(rA[47:40]
rD[59:56] <- sat4s(rA[55:48]
rD[63:60] <- sat4s(rA[63:56]
```

Exceptions:

```
None
```

lv.packs.h Vector Half-word Elements Pack Signed Saturated lv.packs.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x63
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.packs.h rD,rA,rB
```

Description:

The lower half of the signed halfword elements of the general-purpose register rA are truncated and combined with the lower half of the signed half-word truncated elements of the general-purpose register rB in such a way that the lowest elements are from rB, and the highest elements from rA. If any truncated element exceeds a signed 8-bit value, it is saturated. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- sat8s(rB[15:0])
rD[15:8] <- sat8s(rB[31:16])
rD[23:16] <- sat8s(rB[47:32])
rD[31:24] <- sat8s(rB[63:48])
rD[39:32] <- sat8s(rA[15:0])
rD[47:40] <- sat8s(rA[31:16])
rD[55:48] <- sat8s(rA[47:32])
rD[63:56] <- sat8s(rA[63:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.packus.b Vector Byte Elements Pack Unsigned Saturated lv.packus.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x64
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.packus.b rD,rA,rB
```

Description:

The lower half of the unsigned byte elements of the general-purpose register rA are truncated and combined with the lower half of the unsigned byte truncated elements of the general-purpose register rB in such a way that the lowest elements are from rB, and the highest elements from rA. If any truncated element exceeds an unsigned 4-bit value, it is saturated. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[3:0] <- sat4u(rB[7:0]
rD[7:4] <- sat4u(rB[15:8]
rD[11:8] <- sat4u(rB[23:16]
rD[15:12] <- sat4u(rB[31:24]
rD[19:16] <- sat4u(rB[39:32]
rD[23:20] <- sat4u(rB[47:40]
rD[27:24] <- sat4u(rB[55:48]
rD[31:28] <- sat4u(rB[63:56]
rD[35:32] <- sat4u(rA[7:0]
rD[39:36] <- sat4u(rA[15:8]
rD[43:40] <- sat4u(rA[23:16]
rD[47:44] <- sat4u(rA[31:24]
rD[51:48] <- sat4u(rA[39:32]
rD[55:52] <- sat4u(rA[47:40]
rD[59:56] <- sat4u(rA[55:48]
rD[63:60] <- sat4u(rA[63:56]
```

Exceptions:

```
None
```

lv.packus.h Vector Half-word Elements Pack Unsigned Saturated lv.packus.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x65
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.packus.h rD,rA,rB
```

Description:

The lower half of the unsigned halfword elements of the general-purpose register rA are truncated and combined with the lower half of the unsigned half-word truncated elements of the general-purpose register rB in such a way that the lowest elements are from rB, and the highest elements from rA. If any truncated element exceeds an unsigned 8-bit value, it is saturated. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- sat8u(rB[15:0])
rD[15:8] <- sat8u(rB[31:16])
rD[23:16] <- sat8u(rB[47:32])
rD[31:24] <- sat8u(rB[63:48])
rD[39:32] <- sat8u(rA[15:0])
rD[47:40] <- sat8u(rA[31:16])
rD[55:48] <- sat8u(rA[47:32])
rD[63:56] <- sat8u(rA[63:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.perm.n Vector Nibble Elements Permute lv.perm.n

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x66
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.perm.n rD,rA,rB
```

Description:

The 4-bit elements of general-purpose register rA are permuted according to the corresponding 4-bit values in general-purpose register rB. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[3:0] <- rA[rB[3:0]*4+3:rB[3:0]*4]
rD[7:4] <- rA[rB[7:4]*4+3:rB[7:4]*4]
rD[11:8] <- rA[rB[11:8]*4+3:rB[11:8]*4]
rD[15:12] <- rA[rB[15:12]*4+3:rB[15:12]*4]
rD[19:16] <- rA[rB[19:16]*4+3:rB[19:16]*4]
rD[23:20] <- rA[rB[23:20]*4+3:rB[23:20]*4]
rD[27:24] <- rA[rB[27:24]*4+3:rB[27:24]*4]
rD[31:28] <- rA[rB[31:28]*4+3:rB[31:28]*4]
rD[35:32] <- rA[rB[35:32]*4+3:rB[35:32]*4]
rD[39:36] <- rA[rB[39:36]*4+3:rB[39:36]*4]
rD[43:40] <- rA[rB[43:40]*4+3:rB[43:40]*4]
rD[47:44] <- rA[rB[47:44]*4+3:rB[47:44]*4]
rD[51:48] <- rA[rB[51:48]*4+3:rB[51:48]*4]
rD[55:52] <- rA[rB[55:52]*4+3:rB[55:52]*4]
rD[59:56] <- rA[rB[59:56]*4+3:rB[59:56]*4]
rD[63:60] <- rA[rB[63:60]*4+3:rB[63:60]*4]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.rl.b Vector Byte Elements Rotate Left lv.rl.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x67
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.rl.b rD,rA,rB
```

Description:

The contents of byte elements of general-purpose register rA are rotated left by the number of bits specified in the lower 3 bits in each byte element of general-purpose register rB. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] rl rB[2:0]
rD[15:8] <- rA[15:8] rl rB[10:8]
rD[23:16] <- rA[23:16] rl rB[18:16]
rD[31:24] <- rA[31:24] rl rB[26:24]
rD[39:32] <- rA[39:32] rl rB[34:32]
rD[47:40] <- rA[47:40] rl rB[42:40]
rD[55:48] <- rA[55:48] rl rB[50:48]
rD[63:56] <- rA[63:56] rl rB[58:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.rl.h Vector Half-Word Elements Rotate Left lv.rl.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x68
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.rl.h rD,rA,rB
```

Description:

The contents of half-word elements of general-purpose register rA are rotated left by the number of bits specified in the lower 4 bits in each half-word element of general-purpose register rB. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] rl rB[3:0]
rD[31:16] <- rA[31:16] rl rB[19:16]
rD[47:32] <- rA[47:32] rl rB[35:32]
rD[63:48] <- rA[63:48] rl rB[51:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.sll Vector Shift Left Logical lv.sll

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x6b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sll rD,rA,rB
```

Description:

The contents of general-purpose register rA are shifted left by the number of bits specified in the lower 4 bits in each byte element of general-purpose register rB, inserting zeros into the low-order bits of rD. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] << rB[2:0]
```

Exceptions:

```
None
```

lv.sll.b Vector Byte Elements Shift Left Logical lv.sll.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x69
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sll.b rD,rA,rB
```

Description:

The contents of byte elements of general-purpose register rA are shifted left by the number of bits specified in the lower 3 bits in each byte element of general-purpose register rB, inserting zeros into the low-order bits. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] << rB[2:0]
rD[15:8] <- rA[15:8] << rB[10:8]
rD[23:16] <- rA[23:16] << rB[18:16]
rD[31:24] <- rA[31:24] << rB[26:24]
rD[39:32] <- rA[39:32] << rB[34:32]
rD[47:40] <- rA[47:40] << rB[42:40]
rD[55:48] <- rA[55:48] << rB[50:48]
rD[63:56] <- rA[63:56] << rB[58:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.sll.h Vector Half-Word Elements Shift Left Logical lv.sll.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x6a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sll.h rD,rA,rB
```

Description:

The contents of half-word elements of general-purpose register rA are shifted left by the number of bits specified in the lower 4 bits in each half-word element of general-purpose register rB, inserting zeros into the low-order bits. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] << rB[3:0]
rD[31:16] <- rA[31:16] << rB[19:16]
rD[47:32] <- rA[47:32] << rB[35:32]
rD[63:48] <- rA[63:48] << rB[51:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.sra.b Vector Byte Elements Shift Right Arithmetic lv.sra.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x6e
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sra.b rD,rA,rB
```

Description:

The contents of byte elements of general-purpose register rA are shifted right by the number of bits specified in the lower 3 bits in each byte element of general-purpose register rB, inserting the most significant bit of each element into the high-order bits. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] sra rB[2:0]
rD[15:8] <- rA[15:8] sra rB[10:8]
rD[23:16] <- rA[23:16] sra rB[18:16]
rD[31:24] <- rA[31:24] sra rB[26:24]
rD[39:32] <- rA[39:32] sra rB[34:32]
rD[47:40] <- rA[47:40] sra rB[42:40]
rD[55:48] <- rA[55:48] sra rB[50:48]
rD[63:56] <- rA[63:56] sra rB[58:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.sra.h Vector Half-Word Elements Shift Right Arithmetic lv.sra.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x6f
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sra.h rD,rA,rB
```

Description:

The contents of half-word elements of general-purpose register rA are shifted right by the number of bits specified in the lower 4 bits in each half-word element of general-purpose register rB, inserting the most significant bit of each element into the high-order bits. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] sra rB[3:0]
rD[31:16] <- rA[31:16] sra rB[19:16]
rD[47:32] <- rA[47:32] sra rB[35:32]
rD[63:48] <- rA[63:48] sra rB[51:48]
```

Exceptions:

```
None
```

lv.srl Vector Shift Right Logical lv.srl

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x70
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.srl rD,rA,rB
```

Description:

The contents of general-purpose register rA are shifted right by the number of bits specified in the lower 4 bits in each byte element of general-purpose register rB, inserting zeros into the high-order bits of rD. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] » rB[2:0]
```

Exceptions:

```
None
```

lv.srl.b Vector Byte Elements Shift Right Logical lv.srl.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x6c
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.srl.b rD,rA,rB
```

Description:

The contents of byte elements of general-purpose register rA are shifted right by the number of bits specified in the lower 3 bits in each byte element of general-purpose register rB, inserting zeros into the high-order bits. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] » rB[2:0]
rD[15:8] <- rA[15:8] » rB[10:8]
rD[23:16] <- rA[23:16] » rB[18:16]
rD[31:24] <- rA[31:24] » rB[26:24]
rD[39:32] <- rA[39:32] » rB[34:32]
rD[47:40] <- rA[47:40] » rB[42:40]
rD[55:48] <- rA[55:48] » rB[50:48]
rD[63:56] <- rA[63:56] » rB[58:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.srl.h Vector Half-Word Elements Shift Right Logical lv.srl.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x6d
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.srl.h rD,rA,rB
```

Description:

The contents of half-word elements of general-purpose register rA are shifted right by the number of bits specified in the lower 4 bits in each half-word element of general-purpose register rB, inserting zeros into the high-order bits. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] » rB[3:0]
rD[31:16] <- rA[31:16] » rB[19:16]
rD[47:32] <- rA[47:32] » rB[35:32]
rD[63:48] <- rA[63:48] » rB[51:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.sub.b　　Vector Byte Elements Subtract Signed　　lv.sub.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x71
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sub.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rB are subtracted from the byte elements of general-purpose register rA to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] - rB[7:0]
rD[15:8] <- rA[15:8] - rB[15:8]
rD[23:16] <- rA[23:16] - rB[23:16]
rD[31:24] <- rA[31:24] - rB[31:24]
rD[39:32] <- rA[39:32] - rB[39:32]
rD[47:40] <- rA[47:40] - rB[47:40]
rD[55:48] <- rA[55:48] - rB[55:48]
rD[63:56] <- rA[63:56] - rB[63:56]
```

Exceptions:

```
None
```

lv.sub.h Vector Half-Word Elements Subtract Signed lv.sub.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x72
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.sub.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rB are subtracted from the half-word elements of general-purpose register rA to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] - rB[15:0]
rD[31:16] <- rA[31:16] - rB[31:16]
rD[47:32] <- rA[47:32] - rB[47:32]
rD[63:48] <- rA[63:48] - rB[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.subs.b Vector Byte Elements Subtract Signed Saturated lv.subs.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x73
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.subs.b rD,rA,rB
```

Description:

The byte elements of general-purpose register rB are subtracted from the byte elements of general-purpose register rA to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- sat8s(rA[7:0] + rB[7:0])
rD[15:8] <- sat8s(rA[15:8] + rB[15:8])
rD[23:16] <- sat8s(rA[23:16] + rB[23:16])
rD[31:24] <- sat8s(rA[31:24] + rB[31:24])
rD[39:32] <- sat8s(rA[39:32] + rB[39:32])
rD[47:40] <- sat8s(rA[47:40] + rB[47:40])
rD[55:48] <- sat8s(rA[55:48] + rB[55:48])
rD[63:56] <- sat8s(rA[63:56] + rB[63:56])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.subs.h Vector Half-Word Elements Subtract Signed Saturated lv.subs.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x74
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.subs.h rD,rA,rB
```

Description:

The half-word elements of general-purpose register rB are subtracted from the half-word elements of general-purpose register rA to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat16s(rA[15:0] - rB[15:0])
rD[31:16] <- sat16s(rA[31:16] - rB[31:16])
rD[47:32] <- sat16s(rA[47:32] - rB[47:32])
rD[63:48] <- sat16s(rA[63:48] - rB[63:48])
```

Exceptions:

```
None
```

lv.subu.b Vector Byte Elements Subtract Unsigned lv.subu.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x75
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.subu.b rD,rA,rB
```

Description:

The unsigned byte elements of general-purpose register rB are subtracted from the unsigned byte elements of general-purpose register rA to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- rA[7:0] - rB[7:0]
rD[15:8] <- rA[15:8] - rB[15:8]
rD[23:16] <- rA[23:16] - rB[23:16]
rD[31:24] <- rA[31:24] - rB[31:24]
rD[39:32] <- rA[39:32] - rB[39:32]
rD[47:40] <- rA[47:40] - rB[47:40]
rD[55:48] <- rA[55:48] - rB[55:48]
rD[63:56] <- rA[63:56] - rB[63:56]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.subu.h Vector Half-Word Elements Subtract Unsigned lv.subu.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x76
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.subu.h rD,rA,rB
```

Description:

The unsigned half-word elements of general-purpose register rB are subtracted from the unsigned half-word elements of general-purpose register rA to form the result elements. The result elements are placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- rA[15:0] - rB[15:0]
rD[31:16] <- rA[31:16] - rB[31:16]
rD[47:32] <- rA[47:32] - rB[47:32]
rD[63:48] <- rA[63:48] - rB[63:48]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.subus.b Vector Byte Elements Subtract Unsigned Saturated lv.subus.b

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x77
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.subus.b rD,rA,rB
```

Description:

The unsigned byte elements of general-purpose register rB are subtracted from the unsigned byte elements of general-purpose register rA to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- sat8u(rA[7:0] + rB[7:0])
rD[15:8] <- sat8u(rA[15:8] + rB[15:8])
rD[23:16] <- sat8u(rA[23:16] + rB[23:16])
rD[31:24] <- sat8u(rA[31:24] + rB[31:24])
rD[39:32] <- sat8u(rA[39:32] + rB[39:32])
rD[47:40] <- sat8u(rA[47:40] + rB[47:40])
rD[55:48] <- sat8u(rA[55:48] + rB[55:48])
rD[63:56] <- sat8u(rA[63:56] + rB[63:56])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.subus.h Vector Half-Word Elements Subtract Unsigned Saturated lv.subus.h

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x78
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.subus.h rD,rA,rB
```

Description:

The unsigned half-word elements of general-purpose register rB are subtracted from the unsigned half-word elements of general-purpose register rA to form the result elements. If the result exceeds the min/max value for the destination data type, it is saturated to the min/max value and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- sat16u(rA[15:0] - rB[15:0])
rD[31:16] <- sat16u(rA[31:16] - rB[31:16])
rD[47:32] <- sat16u(rA[47:32] - rB[47:32])
rD[63:48] <- sat16u(rA[63:48] - rB[63:48])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.unpack.b **Vector Byte Elements Unpack** **lv.unpack.b**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x79
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.unpack.b rD,rA,rB
```

Description:

The lower half of the 4-bit elements in general-purpose register rA are sign-extended and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[7:0] <- exts(rA[3:0])
rD[15:8] <- exts(rA[7:4])
rD[23:16] <- exts(rA[11:8])
rD[31:24] <- exts(rA[15:12])
rD[39:32] <- exts(rA[19:16])
rD[47:40] <- exts(rA[23:20])
rD[55:48] <- exts(rA[27:24])
rD[63:56] <- exts(rA[31:28])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.unpack.h **Vector Half-Word Elements Unpack** **lv.unpack.h**

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x7a
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.unpack.h rD,rA,rB
```

Description:

The lower half of the 8-bit elements in general-purpose register rA are sign-extended and placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[15:0] <- exts(rA[7:0])
rD[31:16] <- exts(rA[15:8])
rD[47:32] <- exts(rA[23:16])
rD[63:48] <- exts(rA[31:24])
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I

lv.xor Vector Exclusive Or lv.xor

31 26	25 . . . 21	20 . . . 16	15 . . . 11	10 . 8	7 0
opcode 0xa	D	A	B	reserved	opcode 0x7b
6 bits	5 bits	5 bits	5 bits	3 bits	8bits

Format:

```
lv.xor rD,rA,rB
```

Description:

The contents of general-purpose register rA are combined with the contents of general-purpose register rB in a bit-wise logical XOR operation. The result is placed into general-purpose register rD.

32-bit Implementation:

```
N/A
```

64-bit Implementation:

```
rD[63:0] <- rA[63:0] XOR rB[63:0]
```

Exceptions:

```
None
```

Instruction Class
ORVDX64 I