Draft, Do not distribute

h.lw Load Word and Extend with Zero h.lw

15 12	11 8	7 4	3 0
opcode 0x0	N	A	B
4 bits	4 bits	4 bits	4 bits

Format:

```
h.lw rA,N(rB)
```

Description:

```
Offset is sign-extended, left shift 2 bits and added to the contents of general
register rB. Sum represents effective address.  The word in memory addressed
by EA is loaded into general register rA.
```

Operation:

```
EA <- (exts(Immediate)||00) + rB
rA <- (EA)[31:0]
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

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

15 12	11 8	7 4	3 0
opcode 0x0	N	opcode 0x8	B
4 bits	4 bits	4 bits	4 bits

Format:

```
h.lhz r8,N(rB)
```

Description:

Offset is sign-extended, left shift 1 bit and added to the contents of general register rB. Sum represents effective address. The half word in memory addressed by EA is loaded into the low-order 16 bits of general register rA. High-order 16 bits of general register rA are replaced with zero.

Operation:

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

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

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

15 12	11 8	7 4	3 0
opcode 0x0	N	opcode 0x9	B
4 bits	4 bits	4 bits	4 bits

Format:

```
h.lbz r9,N(rB)
```

Description:

Offset is sign-extended and added to the contents of general register rB. Sum represents effective address. The byte in memory addressed by EA is loaded into the low-order eight bits of general register rA. High-order 24 bits of general register rA are replaced with zero.

Operation:

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

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.sw Store Word h.sw

15 12	11 8	7 4	3 0
opcode 0x1	N	A	B
4 bits	4 bits	4 bits	4 bits

Format:

```
h.sw N(rA),rB
```

Description:

```
Offset is sign-extended, left shift 2 bits and added to the contents of general
register rA. Sum represents effective address.  The word in general register
rB is stored to memory addressed by EA.
```

Operation:

```
EA <- (exts(Immediate)||00) + rA
(EA)[31:0] <- rB
```

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.sh Store Half Word h.sh

15 12	11 8	7 4	3 0
opcode 0x1	N	A	opcode 0x8
4 bits	4 bits	4 bits	4 bits

Format:

```
h.sh N(rA),r8
```

Description:

Offset is sign-extended, left shift 1 bit and added to the contents of general register rA. Sum represents effective address. The low-order 16 bits of general register rB are stored to memory addressed by EA.

Operation:

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

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.sb Store Byte h.sb

15 12	11 8	7 4	3 0
opcode 0x1	N	A	opcode 0x9
4 bits	4 bits	4 bits	4 bits

Format:

```
h.sb N(rA),r9
```

Description:

```
Offset is sign-extended and added to the contents of general register rA. Sum
represents effective address.  The low-order 8 bits of general register rB
are stored to memory addressed by EA.
```

Operation:

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

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.movhibsl Immediate Byte shift left by 8 bits and merge and shift left by 1

15 12	11 8	7 4	3 0
opcode 0x2	M	A	M
4 bits	4 bits	4 bits	4 bits

Format:

```
h.movhibsl rA,M
```

Description:

```
8 bit immediate is sign-extended to 32 bits, left shift 8-bit and combine with
the lower 8-bit of the content in register rA and left shift 16-bit.  The result
is put in rA.
```

Operation:

rA <- (exts(Immediate) « 8 || rA[7:0]) « 16

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.movhibse Immediate Byte shift left by 8 bits and merge h.movhibse

15 12	11 8	7 4	3 0
opcode 0x3	M	A	M
4 bits	4 bits	4 bits	4 bits

Format:

```
h.movhibse rA,M
```

Description:

```
8 bit immediate is sign-extended to 32 bits, left shift 8-bit and combine with
the lower 8-bit of the content in register rA The result is put in rA.
```

Operation:

rA <- (exts(Immediate) « 8 || rA[7:0])

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.movibse Immediate Byte Signed Extended h.movibse

15 12	11 8	7 4	3 0
opcode 0x4	M	A	M
4 bits	4 bits	4 bits	4 bits

Format:

```
h.movibse rA,M
```

Description:

```
8 bit immediate is sign-extended to 32 bits and placed into general register
rA.
```

Operation:

rA <- exts(Immediate)

Notes:

Class 2:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Recommended

h.lwpain Load Word with Post Address Increment Register and Extend wi

15 8	7 4	3 0
opcode 0x50	A	N
8 bits	4 bits	4 bits

Format:

```
h.lwpain rA,N
```

Description:

```
PAIR(Post Address Increment Register) represents effective address(EA). The
word in memory addressed by EA is loaded into general register rA.
```

Operation:

```
EA <- PAIR
rA <- (EA)[31:0]
PAIR <- PAIR + N * 4, N= -8 to 7
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.lhzpain Load Half Word with Post Address Increment Register and Exte

15 8	7 4	3 0
opcode 0x51	A	N
8 bits	4 bits	4 bits

Format:

```
h.lhzpain rA,N
```

Description:

PAIR represents effective address. The half word in memory addressed by EA is loaded into the low-order 16 bits of general register rA. High-order 16 bits of general register rA are replaced with zero.

Operation:

EA <- PAIR
rA[15:0] <- (EA)[15:0]
rA[31:16] <- 0
PAIR <- PAIR + N * 2

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.lbzpain Load Byte with Post Address Increment Register and Extend wit

15 8	7 4	3 0
opcode 0x52	A	N
8 bits	4 bits	4 bits

Format:

```
h.lbzpain rA,N
```

Description:

PAIR represents effective address. The byte in memory addressed by EA is loaded into the low-order eight bits of general register rA. High-order 24 bits of general register rA are replaced with zero.

Operation:

EA <- PAIR
rA[7:0] <- (EA)[7:0]
rA[31:8] <- 0
PAIR <- PAIR + N * 1

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.lhspain Load Half Word with Post Address Increment Register and Exte

15 8	7 4	3 0
opcode 0x53	A	N
8 bits	4 bits	4 bits

Format:

```
h.lhspain rA,N
```

Description:

PAIR represents effective address. The half word in memory addressed by EA is loaded into the low-order 16 bits of general register rA. High-order 16 bits of general register rA are replaced with rA[15].

Operation:

EA <- PAIR
rA[15:0] <- (EA)[15:0]
rA[31:16] <- rA[15]
PAIR <- PAIR + N * 2

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.lbspain Load Byte with Post Address Increment Register and Extend wit

15 8	7 4	3 0
opcode 0x54	A	N
8 bits	4 bits	4 bits

Format:

```
h.lbspain rA,N
```

Description:

PAIR represents effective address. The byte in memory addressed by EA is loaded into the low-order eight bits of general register rA. High-order 24 bits of general register rA are replaced with rA[15].

Operation:

EA <- PAIR
rA[7:0] <- (EA)[7:0]
rA[31:8] <- rA[7]
PAIR <- PAIR + N * 1

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.swpai Store Word and Post Address Increment by 4 h.swpai

15 8	7 4	3 0
opcode 0x55	A	B
8 bits	4 bits	4 bits

Format:

```
h.swpai rA,rB
```

Description:

The content of rA represents effective address. The word in general register rB is stored to memory addressed by EA. Besides, the content of rA is incremented by one word

Operation:

EA <- rA
(EA)[31:0] <- rB
rA <- rA + 4

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.shpai Store Half Word and Post Address Increment by 2 h.shpai

15 8	7 4	3 0
opcode 0x56	A	B
8 bits	4 bits	4 bits

Format:

```
h.shpai rA,rB
```

Description:

```
The content of rA represents effective address.  The low-order 16 bits of general
register rB are stored to memory addressed by EA. Besides, the content of rA
is incremented by two bytes
```

Operation:

```
EA <- rA
(EA)[15:0] <- rB[15:0]
rA <- rA + 2
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.sbpai Store Byte and Post Address Increment by 1 h.sbpai

15 8	7 4	3 0
opcode 0x57	A	B
8 bits	4 bits	4 bits

Format:

```
h.sbpai rA,rB
```

Description:

The content of rA represents effective address. The low-order 8 bits of general register rB are stored to memory addressed by EA. Besides, the content of rA is incremented by one byte

Operation:

EA <- rA
(EA)[7:0] <- rB[7:0]
rA <- rA + 1

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.swpain Store Byte and Post Address Increment by signed iMmediate h.s

15 8	7 4	3 0
opcode 0x58	N	B
8 bits	4 bits	4 bits

Format:

```
h.swpain N,rB
```

Description:

The content of rA represents effective address. The low-order 8 bits of general register rB are stored to memory addressed by EA. Besides, the content of rA is incremented by one byte

Operation:

EA <- PAIR
(EA)[7:0] <- rB[7:0]
PAIR <- PAIR + N * 1

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.shpain Store Half Word and Post Address Increment by signed iMmedia

15 8	7 4	3 0
opcode 0x59	N	B
8 bits	4 bits	4 bits

Format:

```
h.shpain N,rB
```

Description:

```
The content of rA represents effective address.  The low-order 16 bits of general
register rB are stored to memory addressed by EA. Besides, the content of rA
is incremented by two bytes
```

Operation:

```
EA <- PAIR
(EA)[15:0] <- rB[15:0]
PAIR <- PAIR + N * 2
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.sbpain Store Word and Post Address Increment by signed iMmediate h.

15 8	7 4	3 0
opcode 0x5a	N	B
8 bits	4 bits	4 bits

Format:

```
h.sbpain N,rB
```

Description:

```
PAIR represents effective address.  The word in general register rB is stored
to memory addressed by EA. Besides, the content of rA is incremented by one
word
```

Operation:

```
EA <- PAIR
(EA)[31:0] <- rB
PAIR <- PAIR + N * 4
```

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.addiu Add Immediate Zero-Extended h.addiu

15 12	11 8	7 4	3 0
opcode 0x6	M	A	M
4 bits	4 bits	4 bits	4 bits

Format:

```
h.addiu rA,M
```

Description:

```
The contents of general register rA are added with Immediate Constant which
is Zero extended.  The result is placed into general register rA.
```

Operation:

rA <- rA + extz(Immediate)

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.addis Add Immediate Sign-Extended h.addis

15 12	11 8	7 4	3 0
opcode 0x7	M	A	M
4 bits	4 bits	4 bits	4 bits

Format:

```
h.addis rA,M
```

Description:

```
The contents of general register rA are added with Immediate Constant which
is sign extended.  The result is placed into general register rA.
```

Operation:

rA <- rA + exts(Immediate)

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.jmp Jump h.jmp

15 12	11 0
opcode 0x8	X
4 bits	12 bits

Format:

```
h.jmp X
```

Description:

```
The immediate(12 bits) is shifted left one bit and added to thecontents of
general register rA to generate program counter.The resultis effective address
of the jump.  The program unconditionally jumps to EA with one delay slot.
```

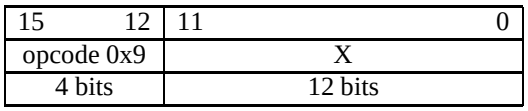
Operation:

PC <- exts(Immediate) + InsnAddr(h.jal)

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.jal Jump and Link Register h.jal



15 12	11 0
opcode 0x9	X
4 bits	12 bits

Format:

```
h.jal X
```

Description:

The immediate(12 bits) is shifted left one bit, sign-extended to 32 bits and then added to the address of h.jal. The result is effective address of the jump. The program unconditionally jumps to EA with one delay slot. The address of the instruction after delay slot is placed in the link register.

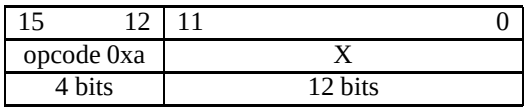
Operation:

PC <- exts(Immediate) + InsnAddr(h.jal)
LR <- h.jal + 2

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.bnf Branch if No Flag h.bnf



15 12	11 0
opcode 0xa	X
4 bits	12 bits

Format:

```
h.bnf X
```

Description:

The immediate(12 bits) is shifted left one bit, sign-extended to 32 bits and then added to the address of h.bnf. The result is effective address of the branch. If the compare flag is cleared, then the program branches to EA with no delay.

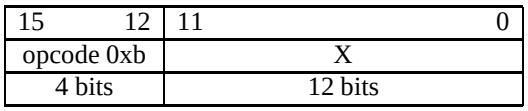
Operation:

EA <- (Immediate || 0) + InsnAddr(h.bnf)
PC <- EA if flag cleared

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.bf Branch if Flag h.bf



15 12	11 0
opcode 0xb	X
4 bits	12 bits

Format:

```
h.bf X
```

Description:

The immediate(12 bits) is shifted left one bit, sign-extended to 32 bits and then added to the address of h.bf. The result is effective address of the branch. If the compare flag is set, then the program branches to EA with no delay slot.

Operation:

EA <- (Immediate || 0) + InsnAddr(h.bf)
PC <- EA if flag set

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.sfeq Set Flag if Equal h.sfeq

15 8	7 4	3 0
opcode 0xc0	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfeq rA,rB
```

Description:

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

Operation:

flag <- rA == rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.sfne Set Flag if Not Equal h.sfne

15 8	7 4	3 0
opcode 0xc1	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfne rA,rB
```

Description:

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

Operation:

flag <- rA != rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc2	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfgts rA,rB
```

Description:

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

Operation:

flag <- rA > rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc3	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfges rA,rB
```

Description:

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

Operation:

flag <- rA >= rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc4	A	B
8 bits	4 bits	4 bits

Format:

```
h.sflts rA,rB
```

Description:

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

Operation:

flag <- rA < rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc5	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfles rA,rB
```

Description:

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

Operation:

flag <- rA <= rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc6	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfgtu rA,rB
```

Description:

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

Operation:

flag <- rA > rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc7	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfgeu rA,rB
```

Description:

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

Operation:

flag <- rA >= rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

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

15 8	7 4	3 0
opcode 0xc8	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfltu rA,rB
```

Description:

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

Operation:

flag <- rA < rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.sfleu Set Flag if Less or Equal Than Unsigned h.sfleu

15 8	7 4	3 0
opcode 0xc9	A	B
8 bits	4 bits	4 bits

Format:

```
h.sfleu rA,rB
```

Description:

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

Operation:

flag <- rA <= rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.exths Extend Half Word with Sign h.exths

15 8	7 4	3 0
opcode 0xca	A	opcode 0x0
8 bits	4 bits	4 bits

Format:

```
h.exths rA
```

Description:

Bit 15 of general register rA is placed in high-order 16 bits of general register rA. The low-order 16 bits of general register rA are left unchanged.

Operation:

rA[31:16] <- rA[15]

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.exthz Extend Half Word with Zero h.exthz

15 8	7 4	3 0
opcode 0xca	A	opcode 0x1
8 bits	4 bits	4 bits

Format:

```
h.exthz rA
```

Description:

```
Zero is placed in high-order 16 bits of general register rA. The low-order
16 bits of general register rA are left unchanged.
```

Operation:

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

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.extbs Extend Byte with Sign h.extbs

15 8	7 4	3 0
opcode 0xca	A	opcode 0x2
8 bits	4 bits	4 bits

Format:

```
h.extbs rA
```

Description:

Bit 7 of general register rA is placed in high-order 24 bits of general register rA. The low-order eight bits of general register rA are left unchanged.

Operation:

rA[31:8] <- rA[7]

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.extbz Extend Byte with Zero h.extbz

15 8	7 4	3 0
opcode 0xca	A	opcode 0x3
8 bits	4 bits	4 bits

Format:

```
h.extbz rA
```

Description:

Zero is placed in high-order 24 bits of general register rA. The low-order eight bits of general register rA are left unchanged.

Operation:

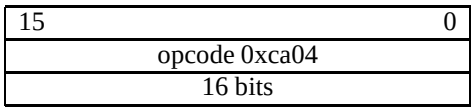
rA[31:8] <- 0

Notes:

Class 2:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Recommended

h.nop No Operation h.nop



Format:

```
h.nop
```

Description:

```
This instruction does not do anything except it takes one clock cycle to complete.
```

Operation:

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.jalr Jump and Link Register h.jalr

15 8	7 4	3 0
opcode 0xca	A	opcode 0x5
8 bits	4 bits	4 bits

Format:

```
h.jalr rA
```

Description:

```
The contents of general register rA is effective address of the jump.  The
program unconditionally jumps to EA with one delay slot.  The address of the
instruction after h.jalr is placed in the link register.
```

Operation:

```
PC <- rA
LR <- h.jalr + 2
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.jr Jump Register h.jr

15 8	7 4	3 0
opcode 0xca	A	opcode 0x6
8 bits	4 bits	4 bits

Format:

```
h.jr rA
```

Description:

The contents of general register rA is effective address of the jump. The program unconditionally jumps to EA with one delay slot. The address of the instruction after h.jr is placed in the link register.

Operation:

PC <- rA

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.muls Multiply Signed h.muls

15 8	7 4	3 0
opcode 0xcb	A	B
8 bits	4 bits	4 bits

Format:

```
h.muls rA,rB
```

Description:

The contents of general register rB and the contents of general register rC are multiplied and the lower 32 bits of the product are placed into general register rA and the higher 32 bits are placed in MACHI. Both operands are treated as signed integers.

Operation:

rA <- rB * rC

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.mulu Multiply Unsigned h.mulu

15 8	7 4	3 0
opcode 0xcc	A	B
8 bits	4 bits	4 bits

Format:

```
h.mulu rA,rB
```

Description:

The contents of general register rB and the contents of general register rC are multiplied and the lower 32 bits of the product are placed into general register rA and the higher 32 bits are placed in MACHI. Both operands are treated as unsigned integers.

Operation:

rA <- rB * rC

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.divs Divide Signed h.divs

15 8	7 4	3 0
opcode 0xcd	A	B
8 bits	4 bits	4 bits

Format:

```
h.divs rA,rB
```

Description:

The contents of general register rA are divided by the contents of general register rB and the result is placed into general register rA. Both operands are treated as signed integers. A divisor flag is set when the divisor is zero.

Operation:

rA <- rA / rB

Notes:

Class 3:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Optional

h.divu Divide Unsigned h.divu

15 8	7 4	3 0
opcode 0xce	A	B
8 bits	4 bits	4 bits

Format:

```
h.divu rA,rB
```

Description:

The contents of general register rA are divided by the contents of general register rB and the result is placed into general register rA. Both operands are treated as unsigned integers. A divisor flag is set when the divisor is zero.

Operation:

rA <- rA / rB

Notes:

Class 3:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Optional

h.mov Move h.mov

15 8	7 4	3 0
opcode 0xd1	A	B
8 bits	4 bits	4 bits

Format:

```
h.mov rA,rB
```

Description:

The contents of general register rB are moved into general register rA.

Operation:

rA <- rB

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.brk software break h.brk

15 8	7 0
opcode 0xd0	M
8 bits	8 bits

Format:

```
h.brk M
```

Description:

```
Software break insn to generate unconditional exception.  PC will be transferred
to exception service routine at 0xD00 and enters Supervisor mode.
```

Operation:

```
PC <- 0x00000D00
```

Notes:

Class 4:	Architecture Level	Execution Mode	Implementation
	System Management	Supervisor only	Mandatory always

h.sys software system call h.sys

15 8	7 0
opcode 0xd8	M
8 bits	8 bits

Format:

```
h.sys M
```

Description:

```
Software system call insn to generate unconditional exception.  PC will be
transferred to exception service routine at 0xC00 and enters Supervisor mode.
```

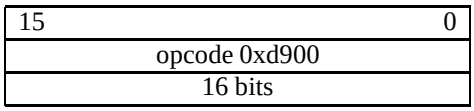
Operation:

```
PC <- 0x00000C00
```

Notes:

Class 4:	Architecture Level	Execution Mode	Implementation
	System Management	Supervisor only	Mandatory always

h.rfe return from software/hardware exception h.rfe



Format:

```
h.rfe
```

Description:

```
Rfe notifies CPU to enter User mode.
```

Operation:

Notes:

Class 4:	Architecture Level	Execution Mode	Implementation
	System Management	Supervisor only	Mandatory always

h.mss multiply signed and accumulate the product h.mss

15 8	7 4	3 0
opcode 0xd2	A	B
8 bits	4 bits	4 bits

Format:

```
h.mss rA,rB
```

Description:

```
The contents of general register rA and the contents of general register rB
are multiplied and the product is subtracted from (MACHI || MACLO) in group
0.  Both operands are treated as signed integers.  MACHI is located in address
3 and MACLO is in address 4 of group 0
```

Operation:

(MACHI || MACLO) <- (MACHI || MACLO) - rA * rB

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.mas multiply signed and accumulate the product h.mas

15 8	7 4	3 0
opcode 0xd3	A	B
8 bits	4 bits	4 bits

Format:

```
h.mas rA,rB
```

Description:

The contents of general register rA and the contents of general register rB are multiplied and the product is added to (MACHI || MACLO) in group 0. Both operands are treated as signed integers. MACHI is located in address 3 and MACLO is in address 4 of group 0

Operation:

(MACHI || MACLO) <- (MACHI || MACLO) + rA * rB

Notes:

Class 2:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Recommended

h.mods Modulus Signed h.mods

15 8	7 4	3 0
opcode 0xd5	A	B
8 bits	4 bits	4 bits

Format:

```
h.mods rA,rB
```

Description:

The contents of general register rA are divided by the contents of general register rB and the result is placed into general register rA. Both operands are treated as signed integers. A divisor flag is set when the divisor is zero.

Operation:

rA <- rA MOD rB

Notes:

Class 3:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Optional

h.modu Modulus Unsigned h.modu

15 8	7 4	3 0
opcode 0xd7	A	B
8 bits	4 bits	4 bits

Format:

```
h.modu rA,rB
```

Description:

The contents of general register rA are divided by the contents of general register rB and the result is placed into general register rA. Both operands are treated as unsigned integers. A divisor flag is set when the divisor is zero.

Operation:

rA <- rA MOD rB

Notes:

Class 3:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Optional

h.swapb Swap byte to exchange Endian h.swapb

15 8	7 4	3 0
opcode 0xd4	A	B
8 bits	4 bits	4 bits

Format:

```
h.swapb rA,rB
```

Description:

```
The bytes of general register rB are swapped mirrorly to exchangethe endianness.The
result is placed into general register rA.
```

Operation:

rA <- (rB[7:0] || rB[15:8] || rB[23:16] || rB[31:24])

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.swaph Swap halfword to exchange Endian h.swaph

15 8	7 4	3 0
opcode 0xd6	A	B
8 bits	4 bits	4 bits

Format:

```
h.swaph rA,rB
```

Description:

```
The halfwords of general register rB are swapped mirrorly to exchange the endianness
The result is placed into general register rA.
```

Operation:

```
rA <- (rB[15:0] || rB[31:16])
```

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.shla Shift Left Arithmetic h.shla

15 8	7 4	3 0
opcode 0xda	A	B
8 bits	4 bits	4 bits

Format:

```
h.shla rA,rB
```

Description:

The contents of general register rA are shifted left arithmetically by the amount of rB[4:0] and the result is placed in rA.

Operation:

rA <- rA « rB[4:0]

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.shra Shift Right Arithmetic h.shra

15 8	7 4	3 0
opcode 0xdc	A	B
8 bits	4 bits	4 bits

Format:

```
h.shra rA,rB
```

Description:

The contents of general register rA are shifted right arithmetically by the amount of rB[4:0] and the result is placed in rA.

Operation:

rA <- rA » rB[4:0]

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.shrl Shift Right Logical h.shrl

15 8	7 4	3 0
opcode 0xde	A	B
8 bits	4 bits	4 bits

Format:

```
h.shrl rA,rB
```

Description:

The contents of general register rA are shifted right logicallyby the amount of rB[4:0] and the result is placed in rA.

Operation:

rA <- rA » rB[4:0]

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.ror Rotate Right h.ror

15 8	7 4	3 0
opcode 0xdb	A	B
8 bits	4 bits	4 bits

Format:

```
h.ror rA,rB
```

Description:

The contents of general register rA are rotated rightby the amount of rB[4:0] and the result is placed in rA.

Operation:

(unused32 || rA) <- (rA || rA) » rB[4:0]

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.rol Rotate Left h.rol

15 8	7 4	3 0
opcode 0xdd	A	B
8 bits	4 bits	4 bits

Format:

```
h.rol rA,rB
```

Description:

```
The contents of general register rA are rotated leftby the amount of rB[4:0]
and the result is placed in rA.
```

Operation:

(rA || unused32) <- (rA || rA) « rB[4:0]

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.notu Not(1s complement) h.notu

15 8	7 4	3 0
opcode 0xe0	A	B
8 bits	4 bits	4 bits

Format:

```
h.notu rA,rB
```

Description:

```
The contents of general register rB is bit-wise inverted The result is placed
into general register rA.
```

Operation:

```
rA <- rB
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.negs Negated(2s complement) h.negs

15 8	7 4	3 0
opcode 0xe1	A	B
8 bits	4 bits	4 bits

Format:

```
h.negs rA,rB
```

Description:

The contents of general register rB is bit-wise inverted and added by 1 The result is placed into general register rA.

Operation:

rA <- -rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.xor Exclusive Or h.xor

15 8	7 4	3 0
opcode 0xe2	A	B
8 bits	4 bits	4 bits

Format:

```
h.xor rA,rB
```

Description:

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

Operation:

rA <- rA XOR rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.or Or h.or

15 8	7 4	3 0
opcode 0xe3	A	B
8 bits	4 bits	4 bits

Format:

```
h.or rA,rB
```

Description:

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

Operation:

rA <- rA OR rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.and And h.and

15 8	7 4	3 0
opcode 0xe4	A	B
8 bits	4 bits	4 bits

Format:

```
h.and rA,rB
```

Description:

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

Operation:

rA <- rA AND rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.xori Exclusive Or Immediate h.xori

15 8	7 0
opcode 0xe5	M
8 bits	8 bits

Format:

```
h.xori r15,M
```

Description:

The contents of general register r15 are combined with Immediate Constant in a bit-wise logical XOR operation. The result is placed into general register r15.

Operation:

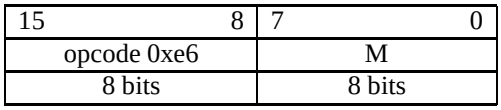
r15 <- r15 XOR Immediate M

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.ori Or Immediate h.ori



15 8	7 0
opcode 0xe6	M
8 bits	8 bits

Format:

```
h.ori r15,M
```

Description:

The contents of general register r15 are combined with Immediate Constant in a bit-wise logical OR operation. The result is placed into general register r15.

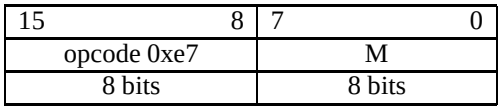
Operation:

r15 <- r15 OR Immediate M

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.andi And Immediate h.andi



15 8	7 0
opcode 0xe7	M
8 bits	8 bits

Format:

```
h.andi r15,M
```

Description:

The contents of general register r15 are combined with Immediate Constant in a bit-wise logical AND operation. The result is placed into general register r15.

Operation:

r15 <- r15 AND Immediate M

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.mtsr Move To Special Register h.mtsr

15 8	7 4	3 0
opcode 0xe8	A	B
8 bits	4 bits	4 bits

Format:

```
h.mtsr rA,rB
```

Description:

The contents of general register rB are moved into special register indexed by rA.

Operation:

rA(rS) <- rB

Notes:

Class 4:

Architecture Level	Execution Mode	Implementation
System Management	Supervisor only	Mandatory always

h.mfsr Move From Special Register h.mfsr

15 8	7 4	3 0
opcode 0xe9	A	B
8 bits	4 bits	4 bits

Format:

```
h.mfsr rA,rB
```

Description:

The contents of special register rB are moved into general register rA.

Operation:

rA <- rB(rS)

Notes:

Class 4:

Architecture Level	Execution Mode	Implementation
System Management	Supervisor only	Mandatory always

h.shlai Shift Left Arithmetic by Immediate Constant h.shlai

15 9	8	7 4	3 0
opcode 0x75	L	A	L
7 bits	1 bits	4 bits	4 bits

Format:

```
h.shlai rA,L
```

Description:

The contents of general register rA are shifted left arithmetically by the amount of 5-bit immediate constant and the result is placed in rA.

Operation:

rA <- rA « Immediate

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.shrai Shift Right Arithmetic by Immediate Constant h.shrai

15 9	8	7 4	3 0
opcode 0x76	L	A	L
7 bits	1 bits	4 bits	4 bits

Format:

```
h.shrai rA,L
```

Description:

The contents of general register rA are shifted right arithmetically by the amount of 5-bit immediate constant and the result is placed in rA.

Operation:

rA <- rA » Immediate

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.shrli Shift Right Logical by Immediate Constant h.shrli

15 9	8	7 4	3 0
opcode 0x77	L	A	L
7 bits	1 bits	4 bits	4 bits

Format:

```
h.shrli rA,L
```

Description:

The contents of general register rA are shifted right logicallyby the amount of 5-bit immediate constant and the result is placed in rA.

Operation:

rA <- rA » Immediate

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.adds Add Signed h.adds

15 8	7 4	3 0
opcode 0xf0	A	B
8 bits	4 bits	4 bits

Format:

```
h.adds rA,rB
```

Description:

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

Operation:

rA <- rA + rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.subs Subtract Signed h.subs

15 8	7 4	3 0
opcode 0xf1	A	B
8 bits	4 bits	4 bits

Format:

```
h.subs rA,rB
```

Description:

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

Operation:

rA <- rA - rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.addu Add UnSigned h.addu

15 8	7 4	3 0
opcode 0xf2	A	B
8 bits	4 bits	4 bits

Format:

```
h.addu rA,rB
```

Description:

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

Operation:

rA <- rA + rB

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.subu Subtract UnSigned h.subu

15 8	7 4	3 0
opcode 0xf3	A	B
8 bits	4 bits	4 bits

Format:

```
h.subu rA,rB
```

Description:

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

Operation:

rA <- rA - rB

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.addwcs Add Signed with carry h.addwcs

15 8	7 4	3 0
opcode 0xf4	A	B
8 bits	4 bits	4 bits

Format:

```
h.addwcs rA,rB
```

Description:

The contents of general register rA and CARRY is added to the contents of general register rB to form the result. The result is placed into general register rA.

Operation:

rA <- rA + rB + CARRY

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.subwcs Subtract Signed with CARRY h.subwcs

15 8	7 4	3 0
opcode 0xf5	A	B
8 bits	4 bits	4 bits

Format:

```
h.subwcs rA,rB
```

Description:

The contents of general register rB is subtracted from the contents of general register rA and CARRY to form the result. The result is placed into general register rA.

Operation:

rA <- rA - rB + C - 1

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.test test bit and set flag h.test

15 8	7 4	3 0
opcode 0xf6	A	B
8 bits	4 bits	4 bits

Format:

```
h.test rA,rB
```

Description:

The contents of general register rA are tested If the bit position in rA pointed by rB is compared with 1. If equal, then flag is set to 1, else flag is set to 0.

Operation:

flag <- rA[rB]

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.testi test bit pointed by immediate constant and set flag h.testi

15 9	8	7 4	3 0
opcode 0x7c	L	A	L
7 bits	1 bits	4 bits	4 bits

Format:

```
h.testi rA,L
```

Description:

```
The contents of general register rA are tested If the bit position in rA pointed
by immediate constant is compared with 1.  If equal, then flag is set to 1,
else flag is set to 0.
```

Operation:

```
flag <- rA[M]
```

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.clr clear bit h.clr

15 8	7 4	3 0
opcode 0xfc	A	B
8 bits	4 bits	4 bits

Format:

```
h.clr rA,rB
```

Description:

If the bit position in rA pointed by general register rB is cleared to ZERO.

Operation:

rA[rB] <- 0

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.clri clear bit pointed by immediate constant h.clri

15 9	8	7 4	3 0
opcode 0x7d	L	A	L
7 bits	1 bits	4 bits	4 bits

Format:

```
h.clri rA,L
```

Description:

If the bit position in rA pointed by immediate constantis cleared to ZERO.

Operation:

rA[M] <- 0

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always

h.set set bit h.set

15 8	7 4	3 0
opcode 0xfd	A	B
8 bits	4 bits	4 bits

Format:

```
h.set rA,rB
```

Description:

```
If the bit position in rA pointed by general register rBis set to ONE.
```

Operation:

rA[rB] <- 1

Notes:

Class 1:	Architecture Level	Execution Mode	Implementation
	Core CPU	User and Supervisor	Mandatory always

h.seti set bit pointed by immediate constant h.seti

15 9	8	7 4	3 0
opcode 0x7f	L	A	L
7 bits	1 bits	4 bits	4 bits

Format:

```
h.seti rA,L
```

Description:

If the bit position in rA pointed by immediate constantis set to ONE.

Operation:

rA[M] <- 1

Notes:

Class 1:

Architecture Level	Execution Mode	Implementation
Core CPU	User and Supervisor	Mandatory always