

# Reference

## Hexadecimal

Hex	Binary	Decimal
0x0	0000	0
0x1	0001	1
0x2	0010	2
0x3	0011	3
0x4	0100	4
0x5	0101	5
0x6	0110	6
0x7	0111	7
0x8	1000	8
0x9	1001	9
0xa	1010	10
0xb	1011	11
0xc	1100	12
0xd	1101	13
0xe	1110	14
0xf	1111	15

## Powers of Two

Power	Hex	Decimal
$2^0$	0x0001	1
$2^1$	0x0002	2
$2^2$	0x0004	4
$2^3$	0x0008	8
$2^4$	0x0010	16
$2^5$	0x0020	32
$2^6$	0x0040	64
$2^7$	0x0080	128
$2^8$	0x0100	256
$2^9$	0x0200	512
$2^{10}$	0x0400	1024
$2^{11}$	0x0800	2048
$2^{12}$	0x1000	4096
$2^{13}$	0x2000	8192
$2^{14}$	0x4000	16384
$2^{15}$	0x8000	32768
$2^{16}$	0x10000	65536

## Arithmetic

$$2^a \times 2^b = 2^{a+b}$$

$$2^a * 2^b = 2^{a+b}$$

$$2^a \div 2^b = 2^{a-b}$$

$$2^a / 2^b = 2^{a-b}$$

# HW ISA

## Instructions

MSB **16-bit Encoding** LSB

Assembly Syntax	Meaning	Opcode	Rs	Rt	Rd
ADD Rs, Rt, Rd	$R[d] \leftarrow R[s] + R[t]$	0010	s	t	d
SUB Rs, Rt, Rd	$R[d] \leftarrow R[s] - R[t]$	0011	s	t	d
AND Rs, Rt, Rd	$R[d] \leftarrow R[s] \& R[t]$	0100	s	t	d
OR Rs, Rt, Rd	$R[d] \leftarrow R[s]   R[t]$	0101	s	t	d
LW Rt, offset(Rs)	$R[t] \leftarrow M[R[s] + \text{offset}]$	0000	s	t	offset
SW Rt, offset(Rs)	$M[R[s] + \text{offset}] \leftarrow R[t]$	0001	s	t	offset
BEQ Rs, Rt, offset	If $R[s] == R[t]$ then $PC \leftarrow PC + 2 + \text{offset} * 2$	0111	s	t	offset
JMP offset	$PC \leftarrow \text{offset} * 2$	1000	offset		
HALT	Stops program execution	1111			

JMP offset is *unsigned*.  
All other offsets are *signed*.