Base Numbering Systems

Bitwise Operations

Base 10	$10^2 = 100$	$10^1 = 10$	$10^0 = 1$
0	0	0	0
1	0	0	1
2	0	0	2
3	0	0	3
4	0	0	4
5	0	0	5
6	0	0	6
7	0	0	7
8	0	0	8
9	0	0	9
10	0	1	0
11	0	1	1
12	0	1	2
13	0	1	3
14	0	1	4
15	0	1	5

Base 16	$16^1 = 16$	$16^0 = 1$
0	0	0
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	A
11	0	B
12	0	C
13	0	D
14	0	E
15	0	F

Base 2	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1

Compliment (~)

~	
~0000	1111
~1111	0000

Bitwise AND (&)

&	0	1
0	0	0
1	0	1

```
10       = 1010
 7       = 0111

10 & 7   = 1010
           0111
           ____
           0010 = 2
```

Bitwise OR (|)

|	0	1
0	0	1
1	1	1

```
10      = 1010
7       = 0111

10 | 7  = 1010
          0111
          ____
          1111 = 15
```

Bitwise EOR (^)

^	0	1
0	0	1
1	1	0

```
10      = 1010
7       = 0111

10 ^ 7  = 1010
          0111
          ----
          1101=13
```

Bitwise Right Shift (>>)

Shifts bits to the right:

$$8 >> 1 = 1000 >> 1 = 0100 = 4$$
$$8 >> 2 = 1000 >> 2 = 0010 = 2$$
$$8 >> 3 = 1000 >> 3 = 0001 = 1$$
$$8 >> 4 = 1000 >> 4 = 0000 = 0$$

Bitwise Left Shift (<<)

Shifts bits to the left:

$$8 << 1 = 1000 << 1 = 10000 = 16$$
$$8 << 2 = 1000 << 2 = 100000 = 32$$
$$8 << 3 = 1000 << 3 = 1000000 = 64$$
$$8 << 4 = 1000 << 4 = 10000000 = 128$$