

8/27/2009 Outline

- Binary Counting
- Addition (Binary)
- Subtraction (Binary) - without 2's complement
- 2's complement

Flip Bits (invert) add 1

Show +5, -5

then show +5
+ -5

0

- Sign Extension
- Overflow
- Conversion

- Decimal to Binary: subtraction
Division

- Show power of 2 table

- Binary to Decimal

- Binary to Hex (Decimal intermediate)

- Hex to Binary

- Show Hex Table + Power 16

1
16
256
4096
65536

Convert

Decimal to Binary:

$$13_{10} \rightarrow \text{Binary}$$

Subtraction:

$$\begin{array}{r} 13 \\ - 8 \\ \hline \end{array} = 2^3$$

$$\begin{array}{r} 5 \\ - 4 \\ \hline \end{array} = 2^2$$

$$\begin{array}{r} 1 \\ - 1 \\ \hline \end{array} = 2^0$$

★

$$\begin{array}{cccccc} 0 & 1 & 1 & 0 & 1 \\ 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \end{array}$$

$$\boxed{1101_2}$$

-13_{10} to Binary

001101

110010

+ 1

$$\boxed{110011_2}$$

Division

$13_{10} \rightarrow \text{Binary}$

.	13		
.	2		
.	6	r	1
.	2		
.	3	r	0
.	2		
.	1	r	1
.	2		
*	0	r	1

1101₂

$$\frac{13}{2} = \frac{6}{2} = 3$$

r₁ r₀

1_2

$$00000001 = +1$$

$$11111110$$

$$+ \quad \quad \quad 1$$

$$\hline 11111111_2 = -1$$

$$00000010$$

$$11111101$$

$$+ \quad \quad \quad 1$$

$$\hline 11111110_2$$

$$\uparrow \underbrace{\hspace{2em}}_2$$

$$-128 + 126 = -2$$

+5

~~$$00000001$$~~

$$00000101_2$$

$$11111010$$

+1

$$\hline 11111011 = -5$$

Power of 2 2^{10}

$$2^0 = 1$$

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

$$2^4 = 16$$

$$2^5 = 32$$

$$2^6 = 64$$

$$2^7 = 128$$

$$+ \begin{pmatrix} 15 \\ 7 \end{pmatrix}$$

8 bits

$$2^8 = 256$$

4 bits

2^3	2^2	2^1	2^0	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	0	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	-8
1	0	0	1	-7
1	0	1	0	-6
1	1	1	1	-

Signed
unsigned

$$2^4 = 16$$

-8 to +7

$$\boxed{-2^{N-1} \text{ to } +2^{N-1} - 1} \text{ Signed}$$

$$-2^3 \quad 2^3 - 1$$

-8 to +7

$$\boxed{0 \text{ to } 2^N - 1} \text{ unsigned}$$

Binary

0
1

Decimal

- 0 to 9

Hexadecimal

0 to 9, A, B, C, D, E, F

1 1 1 1
10 11 12 15

10

0
1

$3_{10} = 11_2$

99

+ 1

100

10
2¹ 2⁰

$36_{10} \rightarrow$ Binary

$36_{16} \rightarrow$ Decimal

111
10111

111

111110

0

10

11

100

101

Binary Addition

11
101

+ 11
1000

1010

+ 10
1100