

$$\begin{array}{r}
 53 \\
 + 22 \\
 \hline
 75
 \end{array}
 \quad
 \begin{array}{r}
 00110101 \\
 + 00010110 \\
 \hline
 01001011
 \end{array}$$

$64 + 8 + 2 + 1 = 75$

$$\begin{array}{r}
 48 \\
 + 40 \\
 \hline
 88
 \end{array}
 \quad
 \begin{array}{r}
 00110000 \\
 + 00101000 \\
 \hline
 01011000
 \end{array}$$

$64 + 16 + 8 = 88$

$$\begin{array}{r}
 200 \\
 + 100 \\
 \hline
 300
 \end{array}
 \quad
 \begin{array}{r}
 \cancel{0}11001000 \\
 + 01100100 \\
 \hline
 00101100
 \end{array}$$

$32 + 8 + 4 = 44$

Sign and magnitude Sign bit 0 +
 1 -

$$\begin{array}{r}
 +5 \\
 -5
 \end{array}
 \quad
 \begin{array}{r}
 00000101 \\
 10000101
 \end{array}
 \quad
 \begin{array}{r}
 0000\ 0000 \\
 1000\ 0000
 \end{array}$$

↑ ↓
sign magnitude

$$7 + 5 = 12 \qquad -7 + 5 = -2$$

$$\begin{array}{r}
 5 \\
 + -5
 \end{array}
 \quad
 \begin{array}{r}
 \cancel{0}0000101 \\
 + 11111011 \\
 \hline
 00000000
 \end{array}
 \quad
 \begin{array}{r}
 \text{OKFB} \\
 11111011 \\
 00000100 \\
 + 1 \\
 \hline
 00000101 \rightarrow +5
 \end{array}$$

Two's Complement Sign bit 0 +
 1 -

To "take the two's complement" of an integer:

- 1) reverse all bits
- 2) add 1

$$\begin{array}{r} -7 \\ +5 \\ \hline \end{array} \quad \begin{array}{r} 11111001 \\ +00000101 \\ \hline 11111110 \end{array} \quad \begin{array}{r} 00000111 \\ 11111000 \\ +1 \\ \hline 11111001 = -7 \end{array}$$

$$\begin{array}{r} 00000001 \\ +1 \\ \hline 00000010 = 2 \end{array}$$

$$\begin{array}{r} 12 \\ +(-5) \\ \hline 7 \end{array} \quad \begin{array}{r} 00001100 \\ +11110111 \\ \hline 00000111 \end{array} \quad \begin{array}{r} OC \\ FB \\ -5 \\ \hline 7 \end{array} \quad \begin{array}{r} 00001100 \\ 11110011 \\ +1 \\ \hline 11110100 = -12 \end{array}$$

$$\begin{array}{r} -12 \\ +5 \\ \hline -7 \end{array} \quad \begin{array}{r} 1110100 \\ 00000100 \\ \hline 11111001 = -7 \end{array} \quad \begin{array}{r} 00000110 \\ +1 \\ \hline 00000111 = 7 \end{array}$$

$$\begin{array}{r} -12 \\ +(-5) \\ \hline -17 \end{array} \quad \begin{array}{r} *11110100 \\ +11111011 \\ \hline 11101111 \end{array} \quad \begin{array}{r} -17 \\ 00010000 \\ +1 \\ \hline 00010001 \\ 16 + 1 = 17 \end{array}$$

$$\begin{array}{r} 120 \\ +100 \\ \hline 220 \end{array} \quad \begin{array}{r} 01111000 \\ +01100100 \\ \hline 11011100 \end{array} \quad \begin{array}{r} = -36 \\ \uparrow \\ 00100011 \\ +1 \\ \hline 00100100 \\ 32 \end{array} \quad \begin{array}{r} 4 \\ = 36 \end{array}$$

$$\overbrace{1000\ 0000} = -128$$

↑
01111111 } +1

10000000

$$01111111 + 127 \text{ or } 7F$$

+1

10000000 = -128

$$-5 \quad \begin{array}{c} \downarrow \\ 11111011 \end{array} \quad 8 \text{ bits}$$

$$+5 \quad \begin{array}{c} \downarrow \\ 00000101 \end{array} \quad 8 \text{ bits}$$

$$+5 \quad \begin{array}{c} \downarrow \\ 0000\ 0000\ 0000\ 0101 \end{array} \quad 16 \text{ bits}$$

$$-5 \quad \begin{array}{c} \downarrow \\ 1111\ 1111\ 1111\ 1011 = -5 \\ 0000\ 0000\ 0000\ 0100 \\ +1 \\ \hline 0000\ 0000\ 0000\ 0101 = 5 \end{array}$$

8-bit

01101001	Pos.
00010000	Pos
11011100	Neg.
10000000	Neg.

Negative? Positive?

↑

8-bit

4C	Pos
7D	Pos
8Z	Neg
C1	Neg

16-bit

C04A	Neg
72A0	Pos
DB1Z	Neg
41AB	Pos