

One's Complement

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These slides introduce one's complement binary number concepts

One's Complement

- 3 variations of signed binary numbers
 - Sign-Magnitude
 - One's Complement
 - Two's Complement
- One's complement is rarely used in digital systems

One's Complement

- Ones Complement
 - Binary representation for a number that is can be positive or negative
 - Characterized by n-bits \rightarrow n bit 1's complement binary number

One's Complement

- Bit values
 - **Negative** numbers are formed by flipping all bits
 - Most Significant Bit (MSB) represents the sign
(but it is NOT a sign bit)
 - MSB = 0 → positive
 - MSB = 1 → negative
 - All bits are used to represent the magnitude of the value
 - Not widely used anymore – but a stepping stone to 2's complement

50	→	0011 0010	Flip bits
-50	→	1100 1101	

One's Complement

- Convert decimal to one's complement

convert -37 decimal to one's complement

8 bits \rightarrow **positive** bit values of x | 64 | 32 | 16 | 8 | 4 | 2 | 1

$s = \text{negative}$ \rightarrow flip all bits at end

$$|-37| = 37$$

greatest bit value $\leq 37 = 32$

$$37 - 32 = 5$$

0 0 1

greatest bit value $\leq 5 = 4$

$$5 - 4 = 1$$

0 0 1 0 0 1

greatest bit value $\leq 1 = 1$

$$1 - 1 = 0$$

0 0 1 0 0 1 0 1



Continued

One's Complement

- Convert decimal to one's complement

convert -37 decimal to one's complement – cont'd

s = negative → flip all bits at end

00100101 → 11011010

-37 → 11011010 one's complement

One's Complement

- Convert 1's complement to decimal

convert 10010110 one's complement to decimal

MSB is 1 (negative) → remember this for the end
→ flip the bits

10010110 → 01101001

8 bits → positive bit values of x | 64 | 32 | 16 | 8 | 4 | 2 | 1

$$1*64 + 1*32 + 0*16 + 1*8 + 0*4 + 0*2 + 1*1$$
$$64 + 32 + 8 + 1 = 105$$

MSB = 1 = negative → -105

10010110_b 1's comp → -105

One's Complement

- Limits
 - Maximum values:
 - 4 bits = $\pm 7 = \pm (2^3-1)$
 - 8 bits = $\pm 127 = \pm (2^7-1)$
 - 16 bits = $\pm 32,767 = \pm (2^{15}-1)$

7	6	5	4	3	2	1	0	0	-1	-2	-3	-4	-5	-6	-7
0111	0110	0101	0100	0011	0010	0001	0000	1111	1110	1101	1100	1011	1010	1001	1000

One's Complement

- Issues
 - 2 zeros really causes a lot of problems

7	6	5	4	3	2	1	0	0	-1	-2	-3	-4	-5	-6	-7
0111	0110	0101	0100	0011	0010	0001	0000	1111	1110	1101	1100	1011	1010	1001	1000