

Binary Numbers

- Assume 1-bit numbers:

Only two different numbers can be represented:

0
1

- Assume 2-bit numbers:

Four different numbers can be represented:

00 - 0
01 - 1
10 - 2
11 - 3

- Assume 3-bit numbers:

Eight different numbers can be represented:

000 - 0
001 - 1
010 - 2
011 - 3
100 - 4
101 - 5
110 - 6
111 - 7

Hexadecimal Numbers

- Assume 4-bit binary numbers:

Sixteen different numbers can be represented:

<u>Binary</u>	<u>Decimal</u>	<u>Hexadecimal</u>
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

- Example:

$$(0100001010100101011011110001)_2 = (?)_{16}$$

0100 0010 1010 0101 0110 1111 0001

$$= (4\ 2\ A\ 5\ 6\ F\ 1)_{16}$$

- Example:

$$(AF52C)_{16} = (?)_2$$

A F 5 2 C

$$= (1010\ 1111\ 0101\ 0010\ 1100)_2$$

Signed Numbers

The leftmost bit is used to indicate the sign of the number:

- 0 - positive
- 1 - negative

Negative numbers are represented in two's complement form.

<i>Bit Pattern</i>	<i>Decimal Value</i>
10000000000000000000000000000000	$(-2^{31} = -2,147,483,648)$
10000000000000000000000000000001	$(-2^{31}-1 = -2,147,483,647)$
10000000000000000000000000000010	$(-2^{31}-2 = -2,147,483,646)$
.	
.	
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111111111111111111111111111111101	(-3)
111111111111111111111111111111110	(-2)
111111111111111111111111111111111	(-1)
00000000000000000000000000000000	(0)
00000000000000000000000000000001	(1)
00000000000000000000000000000010	(2)
00000000000000000000000000000011	(3)
.	
.	
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011111111111111111111111111111101	$(2^{31}-3 = 2,147,483,645)$
011111111111111111111111111111110	$(2^{31}-2 = 2,147,483,646)$
011111111111111111111111111111111	$(2^{31}-1 = 2,147,483,647)$

Representing integers as bit patterns.

- Note: Real numbers (e.g., 256.78) use floating point notation to represent the mantissa and the exponent of the number.

$$256.78 = 2.5678 \times 10^2$$