

# Binary Number Examples

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# Binary Number Examples

It is common to break binary numbers into nibbles to make them easier to read (space between nibbles)

## Unsigned binary (binary)

### Binary number indices (foo)

msb	1	0	1	1	0	1	0	0	lsb
	7	6	5	4	3	2	1	0	

### Binary number values

1	0	1	1	0	1	0	0
128	64	32	16	8	4	2	1

foo[3] = 0  
foo[5] = 1  
foo[8] = ??  
foo[6-3] = 0110

msb – most significant bit  
lsb – least significant bit

1000 0010 = 128 + 2 = 130  
0110 0110 = 64 + 32 + 4 + 2 = 102  
72 = 64 + 8 = 0100 1000  
45 = 32 + 8 + 4 + 1 = 0010 1101

Max value (8b) = 1111 1111 = 255

Min value (8b) = 0000 0000 = 0

# Binary Number Examples

## signed binary (2's Complement)

### Binary number indices (foo)

1	0	1	1	0	1	0	0
7	6	5	4	3	2	1	0

foo[3] = 0  
foo[5] = 1  
foo[8] = ??  
foo[6-3] = 0110

Identical to unsigned binary

### If positive (most significant bit = 0)

### Binary number values

0	0	1	1	0	1	0	0
xxx	64	32	16	8	4	2	1

0100 0010 = 64 + 2 = 66  
0110 0110 = 64 + 32 + 4 + 2 = 102  
72 = 64 + 8 = 0100 1000  
45 = 32 + 8 + 4 + 1 = 0010 1101

Max value (8b) = **0111 1111 = 127**

# Binary Number Examples

signed binary (2's Complement)

If negative (most significant bit = 1)

Binary number values

1	0	1	1	0	1	0	0
xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx

Must convert to find the value

Flip  
Add 1  
Evaluate

Flip

0	1	0	0	1	0	1	1
---	---	---	---	---	---	---	---

Add 1

					1	1	
0	1	0	0	1	0	1	1
+ 0	0	0	0	0	0	0	1
<hr/>							
0	1	0	0	1	1	0	0

Evaluate

$64 + 8 + 6 = 78$   
Answer = -78

Min value (8b) =  $1000\ 000 = -128$

# Binary Number Examples

It is common to break binary numbers into nibbles to make them easier to read (space between nibbles)

## signed binary (2's Complement)

Signed 0010 1100 → decimal  
positive → just evaluate  
 $32 + 8 + 4 = 44$

Signed 0100 1010 → decimal  
positive → just evaluate  
 $64 + 8 + 2 = 74$

Signed 1100 1000 → decimal  
negative → flip, +1, evaluate  
$$\begin{array}{r} 0011\ 0111 \text{ flip} \\ 0000\ 0001 \text{ +1} \\ \hline 0011\ 1000 \\ 32 + 16 + 8 = 56 \rightarrow -56 \end{array}$$

Signed 1110 0000 → decimal  
negative → flip, +1, evaluate  
$$\begin{array}{r} 0001\ 1111 \text{ flip} \\ 0000\ 0001 \text{ +1} \\ \hline 0010\ 0000 \\ 32 = 32 \rightarrow -32 \end{array}$$

62 → signed(8b)  
positive → just convert  
 $62 = 32 + 16 + 8 + 4 + 2 \rightarrow 0011\ 1110$

14 → signed(8b)  
positive → just convert  
 $14 = 8 + 4 + 2 \rightarrow 0000\ 1110$

-14 → signed(8b)  
negative → convert, flip, +1  
$$\begin{array}{r} 14 = 8 + 4 + 2 \rightarrow 0000\ 1110 \\ 1111\ 0001 \text{ flip} \\ 0000\ 0001 \text{ +1} \\ \hline 1111\ 1110 \end{array}$$

-53 → signed(8b)  
negative → convert, flip, +1  
$$\begin{array}{r} 53 = 32 + 16 + 4 + 2 + 1 \rightarrow 0011\ 0111 \\ 1100\ 1000 \text{ flip} \\ 0000\ 0001 \text{ +1} \\ \hline 1100\ 1001 \end{array}$$

# Binary Number Examples

## Hex conversion

Don't over complicate this – just convert each nibble

Dec values: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Hex values: 0 1 2 3 4 5 6 7 8 9 A B C D E F

Indicate hex with 0x

1001	1100	1010	0110	0111	1001	1101
9	12	10	6	7	9	13
0x 9	C	A	6	7	9	D
<b>0x9CA679D</b>						

0x47BDF2C						
0x 4	7	B	D	F	2	C
4	7	11	13	15	2	12
<b>0100 0111 1011 1101 1111 0010 1100</b>						

1011	1100	0110	1010	0101	0000	1111
11	12	6	10	5	0	15
0x B	C	6	A	5	0	F
<b>0xBC6A50F</b>						

0xABC012E						
0x A	B	C	0	1	2	E
10	11	12	0	1	2	14
<b>1010 1011 1100 0000 0001 0010 1110</b>						