

# 2021-01-25 Binary Numbers

Monday, January 25, 2021 2:56 PM

## Base 10 numbers

$10^4$	$10^3$	$10^2$	$10^1$	$10^0$
10000	1000	100	10	1

16,432

10000	6000	400	30	2
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$$10000+6000+400+30+2 = 16432$$

## Binary Numbers

$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
16	8	4	2	1

10011

1	0	0	1	1
16	0	0	2	1

$$16 + 2 + 1 = 19$$

$2^{10}$	$2^9$	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
1024	512	256	128	64	32	16	8	4	2	1

$$1178 - 1024 = 154$$

$$154 - 128 = 26$$

$$26 - 16 = 10$$

$$10 - 8 = 2$$

$$2 - 2 = 0$$

1	0	0	1	0	0	1	1	0	1	0
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1178 in binary is 10010011010

## You try...

1110100101

1	1	1	0	1	0	0	1	0	1
512	256	128	64	32	16	8	4	2	1

$$512 + 256 + 128 + 32 + 4 + 1 = 933$$

$$763 - 512 = 251$$

$$251 - 128 = 123$$

$$123 - 64 = 59$$

$$59 - 32 = 27$$

$$27 - 16 = 11$$

$$11 - 8 = 3$$

1	0	1	1	1	1	1	0	1	1
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## Hexadecimal (base 16)

0...9 is the same as in decimal

A = 10

B = 11

C = 12

D = 13

E = 14

F = 15

$16^3$	$16^2$	$16^1$	$16^0$
4096	256	16	1

1A7F

$$4096 \cdot 1 + 256 \cdot 10 + 16 \cdot 7 + 1 \cdot 15 = 6783$$

17,649

$$17649 / 4096 = 4.3088$$

$$4096 \cdot 4 = 16384$$

$$17649 - 16384 = 1265$$

$$1265 / 256 = 4.9414$$

$$1265 - (256 \cdot 4) = 241$$

$$241 / 16 = 15.0625$$

$$241 - (16 \cdot 15) = 1$$

4	4	F	1
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## Hex to Bin

Max value in a 4 digit binary number is 15

1111

$$8 + 4 + 2 + 1 = 15$$

0100	0100	1111	0001
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## Bin to Hex

1101	1000	1110	0110
D	8	E	6

## Example from AND gate

15555

$$15555 - 2^{13} = 7363$$

$$7363 - 2^{12} = 3267$$

$$3267 - 2^{11} = 1219$$

$$1219 - 2^{10} = 195$$

$$195 - 2^9 = -317$$

$$195 - 2^8 = -61$$

$$195 - 2^7 = 67$$

$$67 - 2^6 = 3$$

0	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1
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0011	1100	1100	0011
3	C	C	3

## Negative Binary Numbers

- (When in 2s complement): Any number that begins with a 1 is negative

- In binary,  $N + -N = 0$

	1	0	1	1	0	1	0	1
	1	1	1	0	0	1	1	0
1	1	0	0	1	1	0	1	1

0	0	0	0	0	0	0	1
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0

What is -27 in binary?

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

1	1	1	0	0	1	0	0
							1
1	1	1	0	0	1	0	1
1	1	1	0	0	1	0	1

What is -16 in binary?

0001 0110

0	0	0	1	0	1	1	0
1	1	1	0	1	0	0	1

1	1	1	0	1	0	0	1
							1
1	1	1	0	1	0	1	0

What is -1C in binary

0	0	0	1	1	1	0	0
1	1	1	0	0	0	1	1
							1
1	1	1	0	0	1	0	0