


January 8, 2026

Base 2, 8, 16

$$\begin{array}{cccccccccccc} & 7 & 6 & 5 & 4 & 3 & 2 & 1 & 0 & & & & & \\ \text{Binary } (11111111) & \rightarrow & (& & & & & &) & & & & & \\ & & & & & & & & & & & & & \end{array}$$
$$1 \cdot 2^7 + 1 \cdot 2^6 + 1 \cdot 2^5 + 1 \cdot 2^4 + 1 \cdot 2^3 + 1 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0$$
$$= 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 =$$
$$= 255$$

$$\begin{array}{ccccccc} & 2 & 1 & 0 & & & \\ (377)_8 & = & 3 \cdot 8^2 & + & 7 \cdot 8^1 & + & 7 \cdot 8^0 & = & 255 \end{array}$$

$$\begin{array}{ccccccc} & 1 & 0 & & & & \\ (FF)_{16} & \rightarrow & (& & & &)_{10} \end{array}$$

base 16:

$$16^{\overset{1}{F}} + 16^{\circ F} = 16 \cdot 15 + 15 = 255_{10}$$

Decimal
 $()_{10} \rightarrow ()_2$
 $()_{10} \rightarrow ()_8$
 $()_{10} \rightarrow ()_{16}$

10	A
11	B
12	C
13	D
14	E
15	F

HEX

$$\begin{array}{r}
 255 \mid 2 \\
 \hline
 254 \mid 127 \mid 2 \\
 \hline
 126 \mid 63 \mid 2 \\
 \hline
 62 \mid 31 \mid 2 \\
 \hline
 30 \mid 15 \mid 2 \\
 \hline
 14 \mid 7 \mid 2 \\
 \hline
 6 \mid 3 \mid 2 \\
 \hline
 2 \mid 1 \\
 \hline
 1
 \end{array}$$

$255_{10} = 1111111_2$

A blue arrow points from the final result '1' back to the first '1' in the binary representation '1111111'.

114₁₀

$$\begin{array}{r|l} 114 & 2 \\ \hline 114 & 57 \\ \hline 0 & 56 \\ & 28 \\ & 14 \\ & 7 \\ & 3 \\ & 1 \end{array}$$

1110010₂

$$(0.12)_{10} \rightarrow ()_2 = (.000111)_2$$

$$0.12 \times 2 = \underline{0.24}$$

$$0.24 \times 2 = \underline{0.48}$$

$$0.48 \times 2 = \underline{0.96}$$

$$0.96 \times 2 = \underline{1.92}$$

$$0.92 \times 2 = \underline{1.84}$$

$$0.84 \times 2 = 1.68$$

just
fraction

0
0
0
1
1
1

↓

Dec.	Binary	Dec.	Binary
1	0001	9	1001
2	0010	10	1010
3	0011	11	1011
4	0100	12	1100
5	0101	13	1101
6	0110	14	1110
7	0111	15	1111
8	1000		

A B C D E F
Hex.

Binary addition

$$\begin{array}{r}
 \times \quad 01100 \\
 \quad 10001 \\
 \hline
 \quad 11101
 \end{array}$$

$$\begin{array}{r}
 \overset{1}{+} \overset{1}{1} \overset{1}{0} \overset{1}{1} 1 0 \\
 \underline{10111} \\
 1[01101]
 \end{array}$$

$$(1)_2 + (1)_2 = (10)_2$$

$$(\overset{1}{1}0)_2 + (1)_2 = (11)_2$$

It is overflow, machine should know that it is overflow

Binary subtraction

$$\begin{array}{r}
 \overset{0}{-} \overset{0}{0} \\
 \hline
 0
 \end{array}
 \quad
 \begin{array}{r}
 \overset{1}{-} \overset{1}{1} \\
 \hline
 0
 \end{array}
 \quad
 \begin{array}{r}
 \overset{1}{-} \overset{0}{0} \\
 \hline
 1
 \end{array}
 \quad
 \begin{array}{r}
 \overset{0}{-} \overset{1}{1} \\
 \hline
 1
 \end{array}$$

$$\begin{array}{r}
 -10110 \\
 \underline{10010} \\
 00100
 \end{array}$$

$$\begin{array}{r}
 -10110 \\
 \underline{10011} \\
 00011
 \end{array}$$

1's complement

logic operation

$$(10101111)_2$$

1's complement is inverse of digits

$$(01010000)_2 + 1 \text{ 1's comp.}$$

$$(01010001)_2 \text{ 2's complement}$$

$$(0101)_2 = (5)_{10}$$