January 8, 2026

Base 2, 8, 16

Binary $\left(\overset{7}{1}\overset{6}{1}\overset{5}{1}\overset{4}{1}\overset{3}{1}\overset{2}{1}\overset{1}{1}\overset{0}{1}\right)_2 \rightarrow (\quad)_{10}$

$$1\cdot 2^7 + 1\cdot 2^6 + 1\cdot 2^5 + 1\cdot 2^4 + 1\cdot 2^3 + 1\cdot 2^2 + 1\cdot 2^1 + 1\cdot 2^0$$

$$= 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 =$$

$$= 255_{10}$$

$$\left(\overset{2}{3}\overset{1}{7}\overset{0}{7}\right)_8 = 3\cdot 8^2 + 7\cdot 8^1 + 7\cdot 8^0 = 255_{10}$$

$\left(\overset{1}{F}\overset{0}{F}\right)_{16} \rightarrow (\quad)_{10}$

base 16:

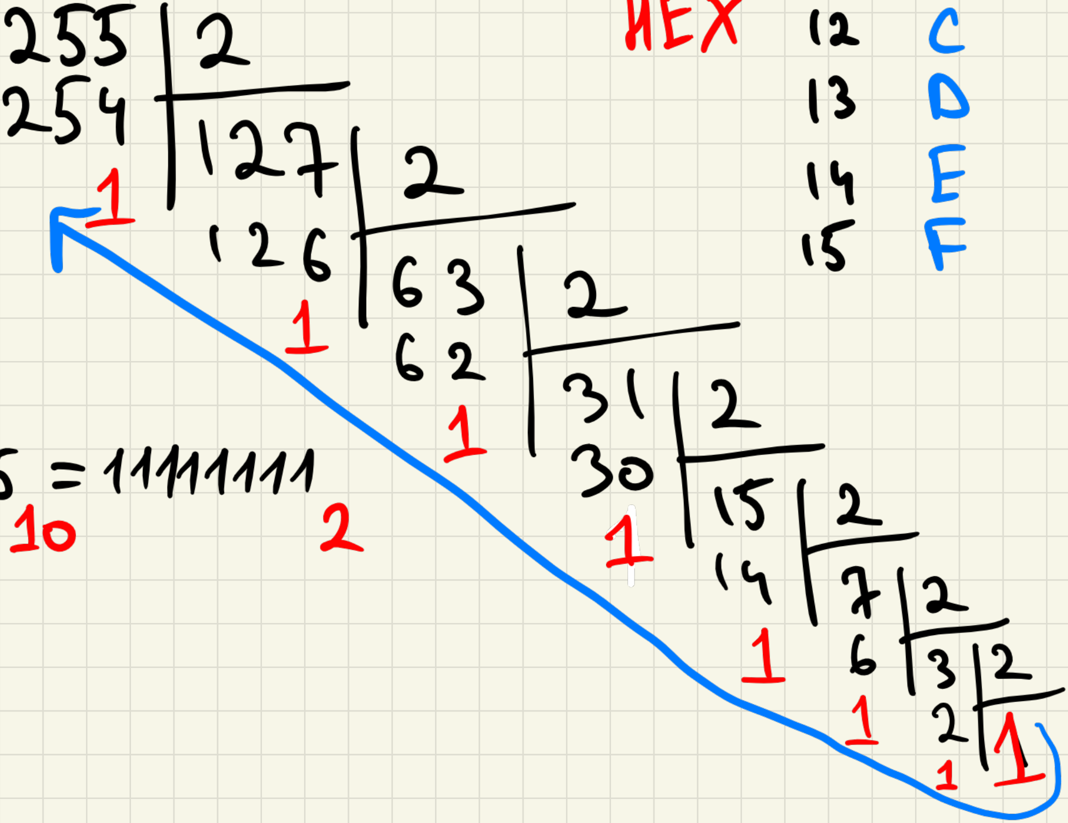
$$16^1 \cdot F + 16^0 \cdot F = 16 \cdot 15 + 15 = 255_{10}$$

Decimal

$$\begin{tikzcd}
 & (\quad)_2 \\
(\quad\quad)_{10} \arrow[ur] \arrow[r] \arrow[dr] & (\quad)_8 \\
 & (\quad)_{16}
\end{tikzcd}$$

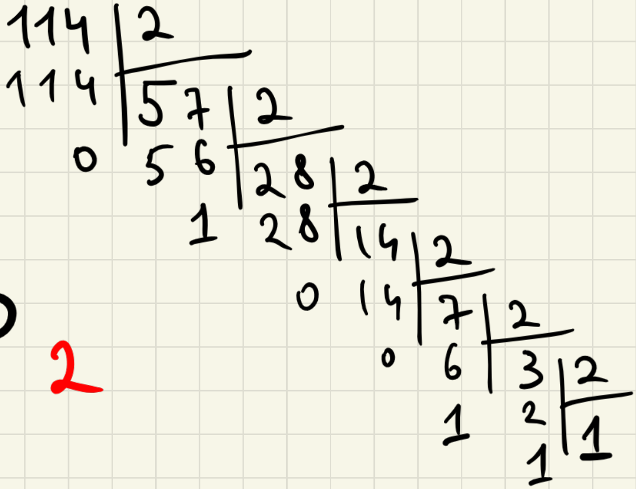
HEX

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



$$255_{10} = 11111111_2$$

114_{10}



1110010_2

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

just fraction

$0.12 \times 2 = \underbrace{0}.24$ — 0

$0.24 \times 2 = \underbrace{0}.48$ — 0

$0.48 \times 2 = \underbrace{0}.96$ — 0

$0.96 \times 2 = 1\underbrace{.92}$ — 1

$0.92 \times 2 = 1\underbrace{.84}$ — 1

$0.84 \times 2 = 1.68$ — 1

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

Binary addition

$$\begin{array}{r} + \; 01100 \\ \underline{1}0001 \\ \hline \boxed{11101} \end{array}$$

$$\begin{array}{cccccc} 1 & & 1 & 1 & & \\ + & 1 & 0 & 1 & 1 & 0 \\ & 1 & 0 & 1 & 1 & 1 \\ \hline \underbrace{1} & [0 & 1 & 1 & 0 & 1] \end{array}$$

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

$$(10)_2+(1)_2=(11)_2$$

It is overflow, machine should know that It is overflow

Binary subtraction

$$\begin{array}{r} 0 \\ -\,0 \\ \hline 0 \end{array} \qquad \begin{array}{r} 1 \\ -\,1 \\ \hline 0 \end{array} \qquad \begin{array}{r} 1 \\ -\,0 \\ \hline 1 \end{array} \qquad \begin{array}{r} 1\leftarrow\;\; \\ 0 \\ -\,1 \\ \hline 1 \end{array}$$

$$\begin{array}{r} 10110 \\ -\,10010 \\ \hline 00100 \end{array} \qquad \begin{array}{r} 10110 \\ -\,10011 \\ \hline 00011 \end{array}$$

1's complement

$(10101111)_2$ logic operation

1's compliment is inverse of digits

(01010000) 1's comp.

$+ \quad 1$

(01010001) 2's compliment

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

January 13, 2026

(r-1)'s r's compliments

radix = base

$r = 10$ $L = 4$ $N = 2468$ $r^4 = 1000$

$r^4 - 1 = 9999$

Therefore

$$\begin{array}{r} 9999 \\ -\,2468 \\ \hline \underline{7531} \end{array}$$

Decimal $(185)_{10}$

Binary $(10111001)_2$

Binary Coded Decimal BCD

$$(459)_{10} \rightarrow (\quad)_{BCD}$$

$$\underline{\quad 0100 \quad} \qquad \underline{\quad 0101 \quad} \qquad \underline{\quad 1001 \quad}$$

BCD range (0-9)

$$4_{10} + 8_{10} = 12_{10}$$

$$0100_2 + 1000_2 = 1100_2 \rightarrow 12_{10}$$

$$0110_2 \rightarrow 6_{10}$$

$$(\underbrace{0001}\,\underbrace{0010})_{BCD}$$

Binary Coded Decimal

$$\begin{array}{r} & 162 \\ + & 769 \\ \hline & 931 \end{array}$$

$$\begin{array}{rccc} & 0001 & 0110 & 0010 \\ + & 0111 & 0110 & 1001 \\ \hline & 1000 & \underbrace{1100} & \underbrace{1011} \end{array}$$

doesn't exist in BCD

more than 9

to solve add 6_{10}

$$\begin{array}{rccc} & & 0110 & 0110 \\ \hline & \underbrace{1001}_{9} & \underbrace{0011}_{3} & \underbrace{0001}_{1} \end{array}$$

encoding → public UTF-8

encryption → special key

BOOLEAN LOGIC

A+B → A or B

A.B → A and B

A', $\bar{A}$ → NOT A

inputs

A	B	$A.B$	$A+B$	A'	B'
0	0	0	0	1	1
0	1	0	1	1	0
1	0	0	1	0	1
1	1	1	1	0	0