

## How to convert binary to decimal

⑦

$$\begin{array}{ccccccc} 1 & 0 & 0 & 1 & 0 & 1 & 0 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 2^6 & 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \end{array}$$

$$64 + 32 + 16 + 8 + 4 + 2 + 1 = \underline{127}$$

$$\begin{array}{ccccccc} 1 & 1 & 0 & 0 & . & 1 & 0 & 1 \\ \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow \\ 2^3 & 2^2 & 2^1 & 2^0 & & 2^{-1} & 2^{-2} & 2^{-3} \end{array}$$

$$8 + 4 + \frac{1}{2} + \frac{1}{8} = 12 + 0.5 + 0.125 = \underline{12.625}$$

## How to convert decimal to binary

$$75 = ?$$

$$(128 \quad \boxed{64} \quad 32 \quad 16 \quad \boxed{8} \quad 4 \quad \boxed{2} \quad \boxed{1})$$

first method:

$$75 - \boxed{64} = 11$$

$$11 - \boxed{8} = 3$$

$$3 - \boxed{2} = \boxed{1}$$

$$\begin{array}{cccc} 75 = & 64 & + & 8 & + & 2 & + & 1 \\ & \downarrow & & \downarrow & & \downarrow & & \downarrow \\ & 2^6 & & 2^3 & & 2^1 & & 2^0 \end{array}$$

$$= 1001011$$

$$339 = ?$$

$$(\boxed{256} \quad 128 \quad \boxed{64} \quad 32 \quad \boxed{16} \quad 8 \quad 4 \quad \boxed{2} \quad \boxed{1})$$

$$339 - \boxed{256} = 83$$

$$83 - \boxed{64} = 19$$

$$19 - \boxed{16} = 3$$

$$3 - \boxed{2} = \boxed{1}$$

$$1 \quad 0 \quad 1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 1 \quad 1$$

$$75 = ?$$

$$75 \div 2 = 37 + \boxed{1} \leftarrow \text{LSB}$$

$$37 \div 2 = 18 + \boxed{1}$$

$$18 \div 2 = 9 + \boxed{0}$$

$$9 \div 2 = 4 + \boxed{1}$$

$$4 \div 2 = 2 + \boxed{0}$$

$$2 \div 2 = 1 + \boxed{0}$$

$$1 \div 2 = 0 + \boxed{1} \leftarrow \text{MSB}$$

$\Rightarrow \boxed{1001011}$

How to convert decimal to hexadecimal

10 based 10  
Decimal is a system. (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)

Hexadecimal is a based 16 system

$\downarrow$        $\downarrow$   
0      10

D	→	H	10	→	A
0	→	0	11	→	B
1	→	1	12	→	C
2	→	2	13	→	D
3	→	3	14	→	E
.....			15	→	F

Ex:

(3)

$$479_{10} \rightarrow 1DF_{16} \quad (?)$$

$$479 \div 16 = 29 + 15 \rightarrow F \quad \text{LSD}$$

$$29 \div 16 = 1 + 13 \rightarrow D$$

$$1 \div 16 = 0 + 1 \rightarrow 1 \quad \text{MSD}$$

$$14259_{10} \rightarrow (?)_{16}$$

$$14259 \div 16 = 891 + 3 \rightarrow 3$$

$$891 \div 16 = 55 + 11 \rightarrow B$$

$$55 \div 16 = 3 + 7 \rightarrow 7$$

$$3 \div 16 = 0 + 3 \rightarrow 3$$

$$37B3_{16}$$

How To convert Hexadecimal to decimal

$$23E_{16} \rightarrow (?)_{10}$$

2 3 E

$\downarrow \quad \downarrow \quad \downarrow$   
 $16^2 \quad 16^1 \quad 16^0$

$$(2 \times 16^2) + (3 \times 16^1) + (14 \times 16^0) = 512 + 48 + 14 = 574_{10}$$

Ex:

④

$$F7D_{16} \rightarrow (?)_{10}$$

$$\begin{array}{ccc} F & 7 & D \\ \downarrow & \downarrow & \downarrow \\ 16^2 & 16^1 & 16^0 \end{array}$$

$$(16^2 \times 15) + (16^1 \times 7) + (16^0 \times 13) = 3840 + 125 = 3965_{10}$$

$$3B4.C8$$

$$(16^2 \times 3) + (16^1 \times 11) + (16^0 \times 4) + (16^{-1} \times 12) + (16^{-2} \times 8)$$

$$= 948.78125$$

convert Hexadecimal to binary

$$A9_{16} \rightarrow (?)_{\text{Binary}}$$

$$\begin{array}{ccc} \downarrow & \searrow & \\ 10 = 8 + 2 & 9 = 8 + 1 & \\ \boxed{8} \ 4 \ \boxed{2} \ 1 & \boxed{8} \ 4 \ 2 \ \boxed{1} \rightarrow 2^0 & \\ \downarrow \ \downarrow \ \downarrow \ \downarrow & \downarrow \ \downarrow \ \downarrow \ \downarrow & \\ 1 \ 0 \ 1 \ 0 & 1 \ 0 \ 0 \ 1 & \\ = \boxed{10101001} & & \end{array}$$

Ex:

5

$$3B7_{16} \rightarrow (?)_2$$

3    11    7

8 4 2 1    8 4 2 1    8 4 2 1

0 0 1 1    1 0 1 1    0 1 1 1

$$= 1110110111$$

How to convert binary to hexadecimal

1	0	1	1	0	1	1	1
2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>
↓	↓	↓	↓	↓	↓	↓	↓
✓	✓	✓	✓	✓	✓	✓	✓
8	4	2	1	8	4	2	1
8+2+1				8+2+1			
11				7			
B				7			

$$\Rightarrow B7_{16}$$

00 10 11 10 10 10  
8 4 2 1    8 4 2 1    8 4 2 1

$$2) (8+4+2) (8+2)$$

$$\Rightarrow 2EA_{16}$$

2    16    10  
↓    ↓    ↓  
2 E    A



## Decimal to octal conversion

⑥

decimal  $\rightarrow$  octal

$$394_{10} \rightarrow (?)_8 \Rightarrow 612_8$$

$$394 \div 8 = 49 \text{ R } 2$$

$$49 \div 8 = 6 \text{ R } 1$$

$$6 \div 8 = 0 \text{ R } 6$$

612<sub>8</sub>

## Octal to decimal conversion

$$370_8 \rightarrow (?)_{10}$$

$8^2 \quad 8^1 \quad 8^0$

$$\frac{(3 \times 8^2)}{192} + \frac{(7 \times 8^1)}{56} + \frac{(0 \times 8^0)}{0} = 298_{10}$$

$$425.28 \rightarrow (?)_{10}$$

$8^2 \quad 8^1 \quad 8^0 \quad 8^{-1} \quad 8^{-2}$

$$(8^2 \times 4) + (8 \times 2) + (5 \times 1) + (2 \times \frac{1}{8}) + (8 \times \frac{1}{64})$$
$$= 277.375_{10}$$

## Octal to binary conversion

(7)

$$56_8 \rightarrow (?)_2 \Rightarrow 101110$$

$$\begin{array}{r|l} 5 & 6 \\ \hline 4 & 2 & 1 & 4 & 2 & 1 \\ \hline 1 & 0 & 1 & 1 & 1 & 0 \end{array}$$

## Binary to Octal conversion

$$\begin{array}{|c|c|} \hline 1 & 1 & 0 & 1 & 0 & 1 \\ \hline 4 & 2 & 1 & 4 & 2 & 1 \\ \hline \end{array} \rightarrow \text{Octal } (?) = 55_8$$

$$\begin{array}{r} (4+2) \\ \hline 6 \end{array} \quad \begin{array}{r} (4+1) \\ \hline 5 \end{array}$$

## Octal to Hexadecimal

$$213_8 \rightarrow (?)_{16} \Rightarrow 213_8 = 8B$$

$$\begin{array}{r|l} 2 & 1 & 3 \\ \hline 4 & 2 & 1 & 4 & 2 & 1 & 4 & 2 & 1 \\ \hline 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{array}$$
  
$$\begin{array}{|c|c|c|} \hline 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ \hline 8 & 4 & 2 & 1 & 8 & 4 & 2 & 1 \\ \hline 8 & & & & 11 & = & B \end{array}$$

# "Hexadecimal To octal conversion"

8

Hex  $\rightarrow$  octal

AC  $\rightarrow$  ?<sub>8</sub>

$\downarrow$  46  
 10 12  


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 8 4 2 1    8 4 2 1  
 1 0 1 0    1 1 0 0

$\Downarrow$

0 1 0    1 0 1    1 0 0  


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 4 2 1    4 2 1    4 2 1

2    5    4  
 (4+1)

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

So: AC<sub>16</sub>  $\rightarrow$  254<sub>8</sub>

## "Decimal to BCD" (Binary Coded Decimal)

356  $\rightarrow$  ? BCD = 0011 0101 0110

3                  5                  6  
 8 4 2 1    8 4 2 1    8 4 2 1  
 (0 0 1 1) (0 1 0 1) (0 1 1 0)



# "BCD to decimal conversion"

9

010110010110 → Decimal (?) = 596

8 4 2 1 8 4 2 1 8 4 2 1

5 9 6

0010001110000000 = 2340

2 3 4 0

## "signed magnitude method"

-6 → ? Binary = 1110

8 4 2 1 7 sign

6 → 0110 → magnitude

-6 → 1110

-7, -12, -15 → 5 bit  $\left\{ \begin{array}{l} 2^{n-1} = 2^{5-1} = 2^4 = 16 \end{array} \right.$

+7 16 8 4 2 1  
0 0 1 1 1  
→ -7 = 10111

+12 16 8 4 2 1  
0 1 0 0 0  
-12 = 11100

15 8 4 2 1  
15 0 1 1 1  
-15 = 1 1 1 1 1

## 2's complement method

(10)

	8	4	2	1	
7 =	0	1	1	1	
	1	0	0	0	1's
+				1	2's
<hr/>					
-7 =	1	0	0	1	

	16	8	4	2	1	
+12	0	1	1	0	0	
	1	0	0	0	1	1's
					1	2's
<hr/>						

-12    1    0    1    0    0

-16    +    4    =    -12

## Subtract Binaries

	32	16	8	4	2	1
	0	1	0	0	1	1
	0	1	0	0	1	1
-	0	0	1	1	0	0
<hr/>						
	0	0	0	1	1	0

⇒

$$32 + 4 + 2 + 1 = 39$$

$$16 + 8 + 1 = 25$$

$$32 + 4 + 2 = \textcircled{14}$$

ASCII: American Standard Code for information interchange, is a character encoding based on the English alphabet. it currently defines codes for 128 characters, 33 are non-printing, mostly obsolete control characters that affect how text is processed, and 95 are printable characters.

RBC (the reflected binary code) = Gray code: is an ordering of the binary numeral system such that two successive values differ <sup>in</sup> only one bit. (~~binary digit~~)

"Binary operations"

$$\begin{array}{r} 0 \\ + 0 \\ \hline 0 \end{array}, \begin{array}{r} 1 \\ + 0 \\ \hline 1 \end{array}, \begin{array}{r} ① 1 \\ + 1 \\ \hline 10 \end{array}, \begin{array}{r} ① 1 \\ + 1 \\ \hline 11 \end{array}.$$

$$1010 + 1001 = (?)$$

$$\begin{array}{r} ① 1010 \rightarrow 10 \\ + 1001 \rightarrow 2 \\ \hline 10011 \rightarrow 19 \end{array}$$

$$\frac{-1}{0}, \frac{-1}{0}, \frac{-1}{01}, \frac{-1}{010}$$

$$\begin{array}{r} \begin{array}{ccc} 0 & 1 & 2 \\ 1 & 0 & 0 \end{array} \rightarrow 4 \\ - \quad \quad \quad 1 \rightarrow -1 \\ \hline 0 \quad 1 \quad 1 \rightarrow 3 \end{array}$$

### "Number Systems"

- ① Decimal system  $\rightarrow$  a base 10 system  
(0, 1, 2, 3, 4, 5, 6, 7, 8, 9)
- ② Binary system  $\rightarrow$  a base 2 system (0, 1)
- ③ Octal system  $\rightarrow$  a base 8 system  
(0, 1, 2, 3, 4, 5, 6, 7)
- ④ Hexadecimal system  $\rightarrow$  a base 16 system  
(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)