

# Number System Conversion:

Decimal → Any	Binary → Any	Octal → Any	Hexadecimal → Any
Decimal → Binary	Binary → Decimal	Octal → Decimal	Hexadecimal → Decimal
Decimal → Octal	Binary → Octal	Octal → Binary	Hexadecimal → Binary
Decimal → Hexadecimal	Binary → Hexadecimal	Octal → Hexadecimal	Hexadecimal → Octal

## Decimal → Any Number System (General Rules)

1. Integer Part Conversion	2. Fractional Part Conversion
<b>Rule:</b> Divide the integer part by the target base. Record remainders. Continue until quotient = 0. Write remainders <b>from bottom to top</b> .	<b>Rule:</b> Multiply the fractional part by the target base. Take the integer part of the result. Repeat with the new fractional part. Write integer parts <b>from top to bottom</b> . Stop when fraction becomes 0 or when required precision is reached.

### 1. Decimal → Binary (Base 2)

✓ Example: Convert  $12.625_{10}$  → Binary

Step 1: Integer part (12)	Step 2: Fractional part (0.625)
$12 \div 2 = 6$ remainder 0 $6 \div 2 = 3$ remainder 0 $3 \div 2 = 1$ remainder 1 $1 \div 2 = 0$ remainder 1 → 1100	$0.625 \times 2 = 1.25$ → 1 $0.25 \times 2 = 0.5$ → 0 $0.5 \times 2 = 1.0$ → 1 → .101

✓ Answer:  $1100.101_2$

### 2. Decimal → Octal (Base 8)

✓ Example: Convert  $125.375_{10}$  → Octal

Step 1: Integer part (125)	Step 2: Fractional part (0.375)
$125 \div 8 = 15$ remainder 5 $15 \div 8 = 1$ remainder 7 $1 \div 8 = 0$ remainder 1 → 175	$0.375 \times 8 = 3.0$ → 3 → .3 ✓ Answer: $175.3_8$

### 3. Decimal → Hexadecimal (Base 16)

✓ Example: Convert  $255.5_{10}$  → Hexadecimal

Step 1: Integer part (255)	Step 2: Fractional part (0.5)
$255 \div 16 = 15$ remainder 15 → F $15 \div 16 = 0$ remainder 15 → F → FF	$0.5 \times 16 = 8.0$ → 8 → .8 ✓ Answer: $FF.8_{16}$

# Binary → Any Number System

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## 1. Binary → Decimal (Base 10)

### Rule

For **integer part**: Multiply each bit by  $2^{\text{position}}$  (position starts from 0 at right).

For **fractional part**: Multiply each bit by  $2^{-\text{position}}$  (position starts from 1 at left of point).

Add everything together.

### ✓ Example: $1101.101_2 \rightarrow$ Decimal

Integer:  $(1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) = 8 + 4 + 0 + 1 = 13$

Fraction:  $(1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3}) = 0.5 + 0 + 0.125 = 0.625$

Answer:  $13.625_{10}$

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## 2. Binary → Octal (Base 8)

### Rule

Group **3 bits** from binary point:

Left side = group from right.

Right side (fraction) = group from left.

Convert each group to octal.

### ✓ Example: $101101.101_2 \rightarrow$ Octal

Integer:  $101101 \rightarrow (101)(101) = 55$

Fraction:  $.101 \rightarrow (101) = 5$

Answer:  $55.5_8$

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## 3. Binary → Hexadecimal (Base 16)

### Rule

Group **4 bits** from binary point:

Left side = group from right.

Right side (fraction) = group from left.

Convert each group to hex (A-F for 10-15).

### ✓ Example: $1110110.101_2 \rightarrow$ Hexadecimal

Integer:  $1110110 \rightarrow (0111)(0110) = 76$

Fraction:  $.101 \rightarrow (1010) = A$

Answer:  $76.A_{16}$

# Octal → Any Number System

## 1. Octal → Decimal (Base 10)

### Rule

For **integer part**: Multiply each digit by  $8^{\text{position}}$ .

For **fractional part**: Multiply each digit by  $8^{-\text{position}}$ .

Add all together.

✓ **Example:  $17.52_8$  → Decimal**

Integer:  $(1 \times 8^1) + (7 \times 8^0) = 8 + 7 = 15$

Fraction:  $(5 \times 8^{-1}) + (2 \times 8^{-2}) = 0.625 + 0.03125 = 0.65625$

Answer:  **$15.65625_{10}$**

## 2. Octal → Binary (Base 2)

### Rule

Replace each **octal digit** with its **3-bit binary equivalent**.

Do this for both integer and fractional parts.

✓ **Example:  $57.4_8$  → Binary**

$5 \rightarrow 101$

$7 \rightarrow 111$

$4 \rightarrow 100$

Answer:  **$101111.100_2$**

## 3. Octal → Hexadecimal (Base 16)

### Rule

Step 1: Convert **Octal** → **Binary** (3-bit groups).

Step 2: Convert **Binary** → **Hexadecimal** (4-bit groups).

✓ **Example:  $345.7_8$  → Hexadecimal**

Step 1: Octal → Binary

$3 = 011$ ,  $4 = 100$ ,  $5 = 101$ ,  $.7 = 111$

Binary =  $011100101.111$

Step 2: Group into 4 bits

Integer:  $0111\ 0010\ 1 \rightarrow \text{pad} \rightarrow 0111\ 0010\ 0001$

Fraction:  $.111 \rightarrow 1110$  (pad)

Hex =  $721.E$

Answer:  **$721.E_{16}$**

# Hexadecimal → Any Number System

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## 1. Hexadecimal → Decimal (Base 10)

### Rule

For **integer part**: Multiply each digit by  $16^{\text{position}}$ .

For **fractional part**: Multiply each digit by  $16^{-\text{position}}$ .

Use **A-F = 10 -15**.

✓ **Example:  $2F.A_{16}$  → Decimal**

Integer:  $(2 \times 16^1) + (15 \times 16^0) = 32 + 15 = 47$

Fraction:  $(10 \times 16^{-1}) = 10/16 = 0.625$

Answer:  **$47.625_{10}$**

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## 2. Hexadecimal → Binary (Base 2)

### Rule

Replace each **hex digit** with its **4-bit binary equivalent**.

Do this for both integer and fractional parts.

✓ **Example:  $3A.C_{16}$  → Binary**

3 → 0011

A (10) → 1010

C (12) → 1100

Answer:  **$00111010.1100_2$**

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## 3. Hexadecimal → Octal (Base 8)

### Rule

Step 1: Convert **Hexadecimal** → **Binary** (4-bit groups).

Step 2: Convert **Binary** → **Octal** (3-bit groups).

✓ **Example:  $2F.A_{16}$  → Octal**

Step 1: Hex → Binary

2 = 0010, F = 1111, A = 1010

Binary = 0010 1111 .1010

Step 2: Group 3 bits

Integer: 000 101 111 = 27

Fraction: .101 000 = 50

Answer:  **$57.5_8$**

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# Conversion: Any → Decimal

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## 1. Binary → Decimal

### Rule

Multiply each binary digit by  $2^{\text{position}}$ .

Integer part → positive powers of 2.

Fractional part → negative powers of 2.

✓ **Example:  $1011.101_2 \rightarrow \text{Decimal}$**

Integer:  $(1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 8 + 0 + 2 + 1 = 11$  Fraction:  $(1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3})$   
 $= 0.5 + 0 + 0.125 = 0.625$

Answer:  **$11.625_{10}$**

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## 2. Octal → Decimal

### Rule

Multiply each digit by  $8^{\text{position}}$ .

Integer part → positive powers of 8.

Fractional part → negative powers of 8.

✓ **Example:  $157.46_8 \rightarrow \text{Decimal}$**

Integer:  $(1 \times 8^2) + (5 \times 8^1) + (7 \times 8^0) = 64 + 40 + 7 = 111$  Fraction:  $(4 \times 8^{-1}) + (6 \times 8^{-2}) = 0.5 + 0.09375 =$   
 $0.59375$

Answer:  **$111.59375_{10}$**

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## 3. Hexadecimal → Decimal

### Rule

Multiply each digit by  $16^{\text{position}}$ .

Integer part → positive powers of 16.

Fractional part → negative powers of 16.

Remember: A=10, B=11, ..., F=15.

✓ **Example:  $2F.A_{16} \rightarrow \text{Decimal}$**

Integer:  $(2 \times 16^1) + (15 \times 16^0) = 32 + 15 = 47$  Fraction:  $(10 \times 16^{-1}) = 10/16 = 0.625$

Answer:  **$47.625_{10}$**

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# END