

2 Conversions Between Binary and Decimal Numbers

binary to decimal

Given a binary number $b_n b_{n-1} b_{n-2} \dots b_2 b_1 b_0$, the equivalent decimal value is

$$b_n \times 2^n + b_{n-1} \times 2^{n-1} + b_{n-2} \times 2^{n-2} + \dots + b_2 \times 2^2 + b_1 \times 2^1 + b_0 \times 2^0$$

Here are some examples of converting binary numbers to decimals:

Binary	Conversion Formula	Decimal
10	$1 \times 2^1 + 0 \times 2^0$	2
1000	$1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$	8
10101011	$1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$	171

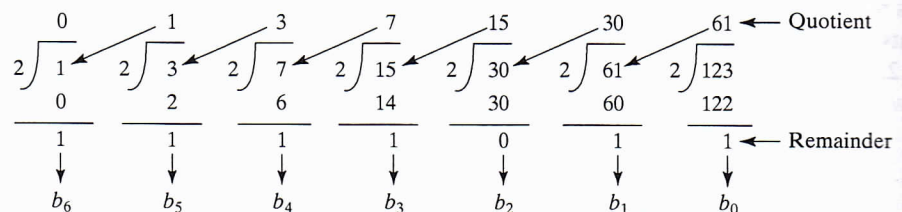
decimal to binary

To convert a decimal number d to a binary number is to find the bits $b_n, b_{n-1}, b_{n-2}, \dots, b_2, b_1$, and b_0 such that

$$d = b_n \times 2^n + b_{n-1} \times 2^{n-1} + b_{n-2} \times 2^{n-2} + \dots + b_2 \times 2^2 + b_1 \times 2^1 + b_0 \times 2^0$$

These bits can be found by successively dividing d by 2 until the quotient is 0. The remainders are $b_0, b_1, b_2, \dots, b_{n-2}, b_{n-1}$, and b_n .

For example, the decimal number 123 is 1111011 in binary. The conversion is done as follows:



Tip

The Windows Calculator, as shown in Figure 1, is a useful tool for performing number conversions. To run it, search for *Calculator* from the *Start* button and launch Calculator, then under *View* select *Scientific*.

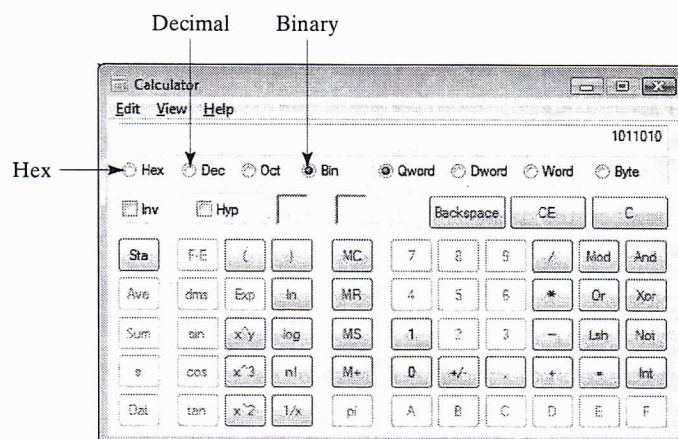


FIGURE 1 You can perform number conversions using the Windows Calculator.