

All about numbers

Mostly used bases: Binary, Octal, Decimal, Hex

Binary: 2 digit system, 0, 1

Octal: 8 digit system, 0 to 7

Decimal: 10 digit system, 0 - 9

Hex: 16 digit system, 0 - 15 (or, precisely, 0 - F)

Formula for converting from any base to decimal:

$$\dots a_3 \cdot \text{base}^3 + a_2 \cdot \text{base}^2 + a_1 \cdot \text{base}^1 + a_0 \cdot \text{base}^0$$

where base is the base of your source number, and bases are raised to power to indicate magnitude.

How we interpret/form decimal numbers:

945 Decimal. Base is 10.

We can show: $9 \cdot 10^2 + 4 \cdot 10^1 + 5 \cdot 10^0 = 9 \cdot 100 + 4 \cdot 10 + 5 \cdot 1 = 900 + 40 + 5 = 945$

Example:

Convert from Binary to Decimal:

$$\begin{aligned} 101101 [b] &= 1 \cdot 2^5 + 0 \cdot 2^4 + 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 \\ &= 1 \cdot 32 + 0 \cdot 16 + 1 \cdot 8 + 1 \cdot 4 + 0 \cdot 2 + 1 \cdot 1 \\ &= 32 + 0 + 8 + 4 + 0 + 1 \\ &= 32 + 8 + 4 + 1 \\ &= 45 \end{aligned}$$

Note: As you can see, values that are 0 in the number are not making any difference during the interpretation since any number multiplied by zero will result in zero.

Therefore it is easier just to calculate the 1's with their respective positional magnitude values as shown in class.

Convert from Hex to Decimal:

Follow similar process.

$$x2FB = 2 \cdot 16^2 + 15 \cdot 16^1 + 11 \cdot 16^0$$

[your base is 16, and remember, in hex, F = 15, B = 11 and so forth]

$$\begin{aligned} &= 2 \cdot 256 + 15 \cdot 16 + 11 \cdot 1 \\ &= 512 + 240 + 11 \\ &= 763 \end{aligned}$$

Formula for converting from Decimal to any base:

1. Divide the decimal number by the desired base
2. Note the remainder – this will be your LSB (Least Significant Bit) (right most)

3. Take the result and divide by the desired base again
4. Note the remainder and append to the left of your LSB from step 2
5. Repeat step 2 and 3 until you get 0 as result.

Example:

Convert Decimal 49 to Binary

Desired base is Binary, which is 2. So start dividing 49 with 2. Following the steps of the formula, we get:

Dividend / Divisor = result, remainder

| | | |
|--------------------------|--------------------------------------|----------|
| 49 / 2 = 24, remainder 1 | Forming the binary number: | LSB is 1 |
| 24 / 2 = 12, remainder 0 | append remainder to the left of LSB: | 01 |
| 12 / 2 = 6, remainder 0 | repeat as above | 001 |
| 6 / 2 = 3, remainder 0 | „ | 0001 |
| 3 / 2 = 1, remainder 1 | „ | 10001 |
| 1 / 2 = 0, remainder 1 | „ | 110001 |

Converting from HEX to BINARY

Simply convert each of the hex numbers in groups of 4 binary equivalents.

Example: x3FA2 to binary:

0011 1111 1010 0010

Converting from BINARY to HEX

Simply group the binary digits in groups of four starting from the RIGHTMOST number, and pad the leftmost group with 0's to make up a group of 4 digits if needed.

Example: 11100110110010

Grouping the numbers in groups of 4 from right most side we get:

11 1001 1011 0010

Pad the left most group with two 0's to make it a group of 4.

0011 1001 1011 0010

Now convert each group to Hex equivalent

Hint: You can convert each group to Decimal and assign A, B, C, D, E, F for 10, 11, 12, 13

After conversion: 3 9 B 2

So result is x39B2