

Number Representation 2 – Hexadecimal Numbers

Hexadecimal numbers are based on the number **16**. A hexadecimal number uses 16 symbols which are 0, 1, 2 ... 8, 9, A, B, C, D, E and F. 'A' stands for ten, 'B' stands for eleven, 'C' stands for twelve etc. The term 'hexadecimal' is shortened to '**hex**'.

The conversions from binary to hex and vice-versa are very simple and straightforward.

In the following table we can see the representations of the numbers from zero to fifteen in the hexadecimal, binary and decimal representations.

Hexadecimal	Binary	Decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

An example of a hex (hexadecimal) number: 3C90B.

Conversion from Binary to Hex

It is easy to convert from an integer binary number to hex. This is accomplished by the following two steps:

1. Break the binary number into 4-bit sections from the LSB (least significant bit) to the MSB (most significant bit).
2. Convert the 4-bit binary number to its Hex equivalent.

The following example shows how the binary value 1010111110110010 is converted to hex.

1010	1111	1011	0010
A	F	B	2

Therefore $1010111110110010_2 = \text{AFB2}_{16}$. Note that we put a subscript of 16 (or H) to indicate a hexadecimal number.

Note that the binary number above consists of 16 bits while the same number in hex consists of only 4 digits. It is for this reason that we use hex numbers. They are used to **shorten** the expression of a number. A binary number is 4 times as long as the same number in hexadecimal notation.

Conversion from Hex to Binary

This conversion procedure is the opposite of the one we saw above. For each hex digit write its binary equivalent in 4 bits. Then write these bits in one sequence e.g. $39\text{B}_{16} = 001110011011_2$. The initial zeros can then be removed.

Conversions from and to Decimal

To avoid working with large numbers (powers of 16), to convert from decimal to hex do the following:

1. Convert the decimal number to binary
2. Convert the result to hex

Likewise, the conversion from hex to decimal is done in the following two steps:

1. Convert the hex number to binary
2. Convert the result to decimal

Exercise

Perform the following conversions:

- a. Convert 10001110101_2 to hex.
- b. Convert 20154_{10} to hex.
- c. Convert 3F7A_{16} to decimal.
- d. Convert 5BA_{16} to binary.