Numbering Systems

IN THIS GUIDE

This guide provides a brief explanation on the numbering systems used in computing.

File: 01_002 Numbering Systems Rev: 4.0 For Beginners PDF version (35kb)

Linear Electronics

In Linear electronics values change with the strength (amplitude) of the signal. It is good for audio amplifiers but no so good for computer data as large calculations require large output voltages. Microvolts are used to reduce these outputs.

Example:
Assuming the number 1 is 1 volt, 8 x 7 = 56 volts and 8000 x 7000 = 56,000 volts.

Digital Electronics

In digital systems numbers are dealt with in binary. A digit is either 1 or 0, to represent either on or off. Typically, this would be 5 volts to represent 1 (on) and 0 volts to represent 0 (off).

> *Example*:
> In binary, 8 = 1000 and 7 = 111, therefore, 8 x 7 = 111000
> now this would require 6 wires at 2 potentials.
>
> 8000 x 7000 = 110101011001111111000000000
> this requires 26 wires at 2 potentials.

Numbering Systems

Decimal

This is used by humans, computers only use it to interface with humans.

- Base number: 10
- Ten number values: 0 1 2 3 4 5 6 7 8 9

1	0	0	0	2	5	1
millions	hundred thousands	ten thousands	thousands	hundreds	tens	units
10^6	10^5	10^4	10^3	10^2	10^1	10^0

> Example
>
> 251 = multiples of units(10^0), tens(10^1) and hundreds(10^2)

Binary

Computers use the binary numbering system with just two number values 0 and 1 which are seen to represent on/off or true/false statements. A single digit is known as a bit. Eight bits together are known as a byte. Multiple bytes together are sometimes called a word. The binary system uses the base power of 2 so $2^2 = 4$ (2 x 2). Therefore, the digit 111 = 4+2+1 = 7 in decimal and 1000 = 8+0+0+0 = 8 in decimal.

- Base number: 2
- Two number values: 0 1

1	1	1	1	1	0	1	1
128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Example

251 = 11111011(128+64+32+16+8+0+2+1)

Hexadecimal

Hexadecimal is used to replace large binary numbers. It is to the base of 16 and, therefore, more compact than binary. The first 10 digits are 0 to 9 whilst 10 through to 15 are represented by the letters A to F. In hexadecimal, 8000 x 7000 = 3567E00, this is clearly more compact than binary. Hexadecimal numbers are pre-fixed by the # character.

- Base number: 16
- Sixteen number values: 0 1 2 3 4 5 6 7 8 9 A B C D E F
note where A=10, B=11, C=12, D=13, E=14, F=15

0	0	0	0	0	F	B
16777216	1048576	65536	4096	256	16	1
16^6	16^5	16^4	16^3	16^2	16^1	16^0

Example

251 = #FB (F=15 so 15x16=240 and B=11, therefore 240+11=251)