What is a signal?

A signal is an electromagnetic or electrical current that carries data from one system to another.

There are two types of signals; **Analog** and **Digital**.

<u>Analog signals</u> are continuous variations of current and voltage.

When plotted on a voltage vs. time graph, an analog signal should produce a smooth and continuous curve.

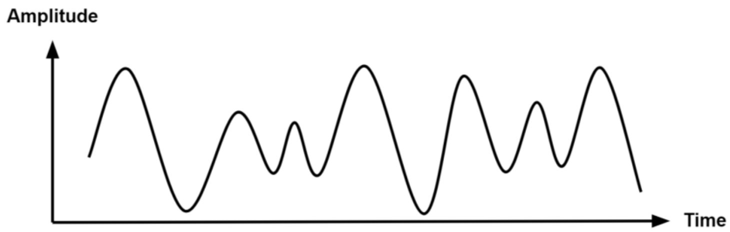


Figure 1 Analog signal

<u>Digital signals</u> that represents data as a sequence of discrete values.

A digital signal can only take on one value from a finite set of possible values at a given time. Digital signals have discrete stepwise value (0 = Low, 1 = High).

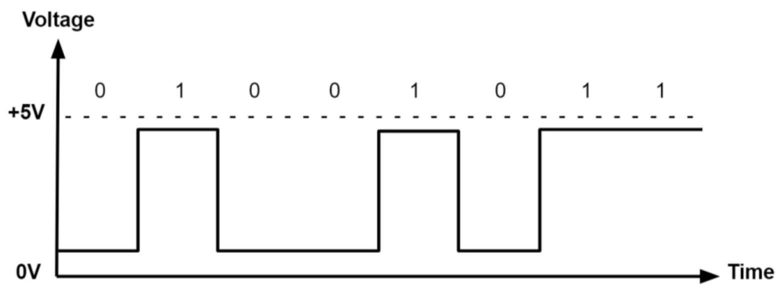


Figure 2 Digital signal

<u>Decimal Number System</u>

The decimal number system is a radix-10 number system and therefore has 10 different digits or symbols. These are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.

Example 1: As an illustration, in the case of the decimal number 3586.265:-

Solution: (***Integer*** *part* & ***Fractional*** *part*)

The **<u>integer part</u>** (i.e. **3586**) can be expressed as

3586 $= 6\times10^{0} + 8\times10^{1} + 5\times10^{2} + 3\times10^{3} = 6+80+500+3000 = 3586$

and the **fractional part** can be expressed as

265 $= 2\times10^{-1}+6\times10^{-2} +5\times10^{-3} = 0.2+0.06+0.005 = 0.265$

Binary Digits

The two digits in the binary system, 1 & 0 are called bits, which is a contraction of the words binary digit.

In digital circuits, two different voltage levels are used to represent the two bits. A **1** is represented by the higher voltage (HIGH) and a **0** is represented by the lower voltage level (LOW). This is called positive logic.

HIGH = 1 : LOW = 0

Codes: groups of bits (combinations of 1s and 0s). Codes are used to represent numbers, letters, symbols, instructions and anything else required in a given application.

Decimal number	Binary number 8421	
0	0000	(LSB) least significant bit
1	0001	
2	0010	
3	0011	
4	0100	
5	0101	
6	0110	
7	0111	
8	1000	
9	1001	
10	1010	
11	1011	
12	1100	
13	1101	
14	1110	
15	1111	

(MSB) most significant bit

Example 2: Find the decimal equivalent of binary number 11010.

Solution:

Binary weight	2^4	2^3	2^2	2^1	2^0
Weight value	16	8	4	2	1
Binary number	1	1	0	1	0

So $(11010)_2 = 1\times16+1\times8+0\times4+1\times2+0\times1=(26)_{10}$ Ans.

Example 3: Obtain the following: Decimal equivalent to $(11011000)_2$.

Solution:

$$\begin{aligned}(11011000)_2 &= 1\times 2^7 + 1\times 2^6 + 0\times 2^5 + 1\times 2^4 \\ &\quad + 1\times 2^3 + 0\times 2^2 + 0\times 2^1 + 0\times 2^0 \\ &= 128 + 64 + 0 + 16 + 8 + 0 + 0 + 0 \\ &= (216)_{10} \text{ Ans.}\end{aligned}$$

Example 4: convert the binary number 1101101 to decimal.

Solution:

Binary Weight:	2^6	2^5	2^4	2^3	2^2	2^1	20
	64	32	16	8	4	2	1
Binary Number:	1 ↓ MSB	1	0	1	1	0	1 ↓ LSB

$$\mathbf{1101101} = 2^6 + 2^5 + 2^3 + 2^2 + 2^0$$

$$= 64 + 32 + 8 + 4 + 1 = \mathbf{109}$$

$$\mathbf{(1101101)_2 = (109)_{10}}$$

Example 5: $(1101.11)_2$ to $(\quad)_{10.}$

Solution:

$(1*2^3) + (1*2^2) + (0*2^1) + (1*2^0) + (1*2^{-1}) + (1*2^{-1})$

$8 + 4 + 0 + 1 + 0.5 + 0.25 = (13.75)_{10}$

Example 6: convert 0.0101 to decimal.

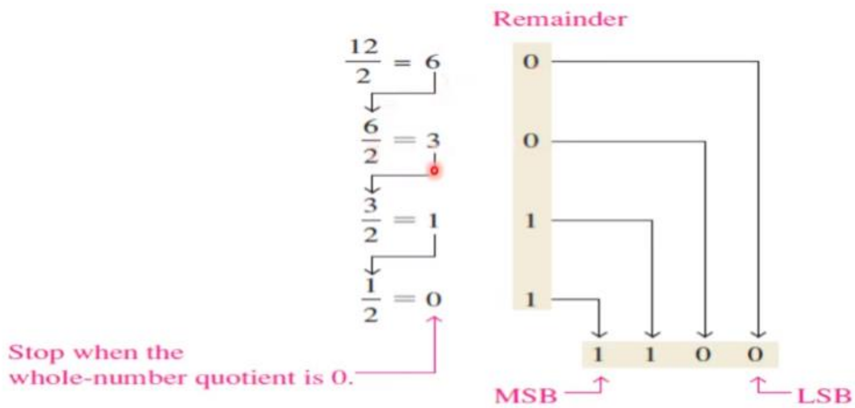
Solution:

$(0*2^0) + (0*2^{-1}) + (1*2^{-2}) + (0*2^{-3}) + (1*2^{-4})$

$0 + 0 + 0.25 + 0 + 0.0625 = (0.13125)_{10}$

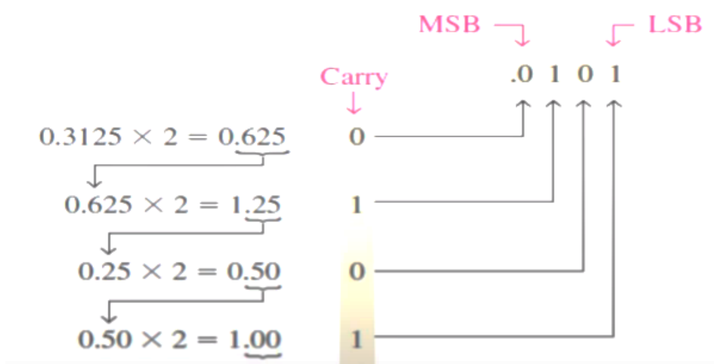
Example 7: Convert 12 to binary.

Solution:



Example 8: Convert 0.3125 to binary.

Solution:



Octal Number System

In the octal number system, we have the 7's and 8's complements. The 7's complement of a given octal number is obtained by subtracting each octal digit from 7. For example, the 7's complement of $(562)_8$ would be $(215)_8$. The 8's complement is obtained by adding '1' to the 7's complement. The 8's complement of $(562)_8$ would be $(216)_8$.

Example 9: Octal-to-Decimal Conversion.

Solution:

The decimal equivalent of the octal number $(137.21)_8$ is determined as follows:

• The integer part = 137

• The decimal equivalent = $7 \times 8^0 + 3 \times 8^1 + 1 \times 8^2 = 7 + 24 + 64 = 95$

• The fractional part = .21

• The decimal equivalent = $2 \times 8^{-1} + 1 \times 8^{-2} = 0.265$

• Therefore, the decimal equivalent of $(137.21)_8$

= $(95.265)_{10}$

Hexadecimal Number System

The 15's and 16's complements are defined with respect to the hexadecimal number system. The 15's complement is obtained by subtracting each hex digit from 15. For example, the 15's complement of $(3BF)_{16}$ would be $(C40)_{16}$. The 16's complement is obtained by adding '1' to the 15's complement. The 16's complement of $(2AE)_{16}$ would be $(D52)_{16}$.

Decimal	*Binary*	*Octal*	*Hexidecimal*
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	*A*
11	1011	13	*B*
12	1100	14	*C*
13	1101	15	*D*
14	1110	16	*E*
15	1111	17	*F*
16	10000	20	10