

Introduction to digital electronics

Analogue & Digital Circuits.

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Introduction

In this topic we are going to discuss the following:

- Meaning of analogue and digital electronics.
- Analogue and Digital signals.
- Characteristics of analogue and digital electronics.
- Difference between analogue and digital circuits.
- Modulation.
- Summary.
- Quiz.

Analogue Electronics

- A branch of electronics that deals with **continuous signals** that vary in time, such as voltage or current.
- Analogue electronics makes use of continuous signals also called analogue signals.
- A continuous signal is a type of signal that varies smoothly over time and can take on any value within a given range.
- Examples of electronic devices that use analogue signals are:
 - Speakers
 - Microphones
 - Headphones
 - Radios
 - Thermostats

Digital Electronics

- This is a field in electronics that deals with **discrete signals**, often represented by binary digits (0s and 1s).
- It involves designing and working with circuits that manipulate discrete signals using components such as **logic gates**.
- A discrete signal is a type of signal that **only takes specific, distinct values** at certain points in time.
- Thus to say, discrete signals have defined values at specific intervals.
- Examples of electronic devices that use discrete signals are:
 - Digital cameras
 - Computers
 - Traffic lights
 - Mobile phones

Analogue and Digital Signals

- An analogue signal also called a continuous signal is a type of signal that **varies smoothly** over time and **can take any value** within a given range.
- Think of analogue signals as **decimal numbers** that starts at **0, 0.1, 0.2, 0.9, 1...**
- A digital signal also called discrete signal is a type of signal that **only takes specific, distinct values** at certain points in time.
- Think of digital signals as **integers** that starts at **1,2,...,6,...**
- **Digital signals** often represented by **binary digits: 0s and 1s**.
- **Figure 0** on the next slide shows the wave forms of an analogue signal and a digital signal.

Analogue and Digital Signals

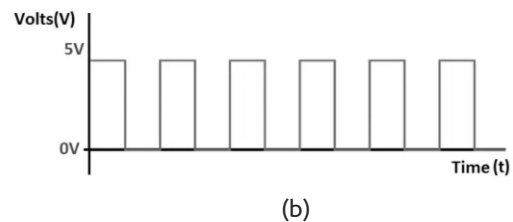
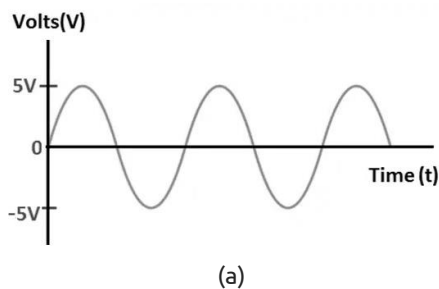


Figure 0: (a) analogue signal, (b) digital signal

Characteristics of analogue signals

As we have seen from **Figure 0**, that an analogue signal is a sinewave, as such it has the following characteristics:

- **Amplitude(A)**: an analogue signal has a maximum displacement of wave particles from its resting position. This can show the maximum and minimum voltage or current in a circuit.
- **Frequency (f)**: this is the number of complete analogue signal waves per second.
- **Phase**: these are two points on a wave front of an analogue signal that appears to be the same.
- **Wavelength (λ)**: this is the distance between any two successive points in phase of an analogue signal.

Characteristics of digital signals

Below are some of the characteristics of digital signals:

- Digital signals are expressed using **binary digits** as such they have **limited number of defined values**, thus a **1** and a **0**.
 - Note: The binary digits (1 and 0) are called **bits**.
- **Bit interval**: this is the time required to send one single bit of a digital signal.
- **Bit rate**: this is the number of bit intervals in a second.
- We can also say that **digital signals are discrete** – thus to say, digital signals are represented using finite set of distinct values.

Difference between analogue and digital circuits

ANALOGUE CIRCUITS

- In analogue circuits data is represented through continuous signals (voltage or current).
- In analogue circuits we have continuous processing.
- Analogue circuits are more prone to noise.
- In analogue circuits we have high **attenuation**.
- Analogue circuits consumes low power.
- Makes use of amplifiers, filters, and other analogue components.

DIGITAL CIRCUITS

- In digital circuits data is represented through discrete signals (binary digits).
- In digital circuits we have discrete processing.
- Digital circuits are more immune to noise.
- In digital circuits we have less **attenuation**.
- In digital circuits power consumption can vary.
- Make use of logic gates, flip flops and other digital components.

Modulation

- We have some electronic device that use both analogue and digital signals.
- In these devices, an analogue signal can be converted to a digital signal when the need arise.
- Example of electronic devices that use both analogue and digital signals are:
 - Smartphones.
 - Digital cameras.
 - Television.
 - Automotive systems.
- The process of converting an analogue signal into a digital signal is called modulation.
- The process of converting a digital signal bac to an analogue signal is called demodulation.

Summary

- In analogue circuits data is represented through continuous signals (voltage or current) while in digital circuits data is represented through discrete signals (binary digits).
- An analogue signal also called a continuous signal is a type of signal that **varies smoothly** over time and **can take any value** within a given range while, A digital signal also called discrete signal is a type of signal that **only takes specific, distinct values** at certain points in time.
- An analogue signal has properties such as amplitude, frequency, and wavelength.
- A digital circuit has properties such as bit interval, and bit rate.
- An analogue circuits we have high attenuation, while in digital circuits we have less attenuation.

Note: ***Attenuation** refers to the decrease in the strength of a signal as it passes through a circuit.*

Quiz

1. What is a digital signal? **(1)**
2. Describe any **two** advantages of a digital circuit over the analogue circuit. **(4)**
3. With the aid of a well labelled diagram, describe any **two** properties of an analogue signal **(6)**
4. Define the term '**demodulation**'. **(1)**
5. List any **three** devices that use analogue signals. **(3)**