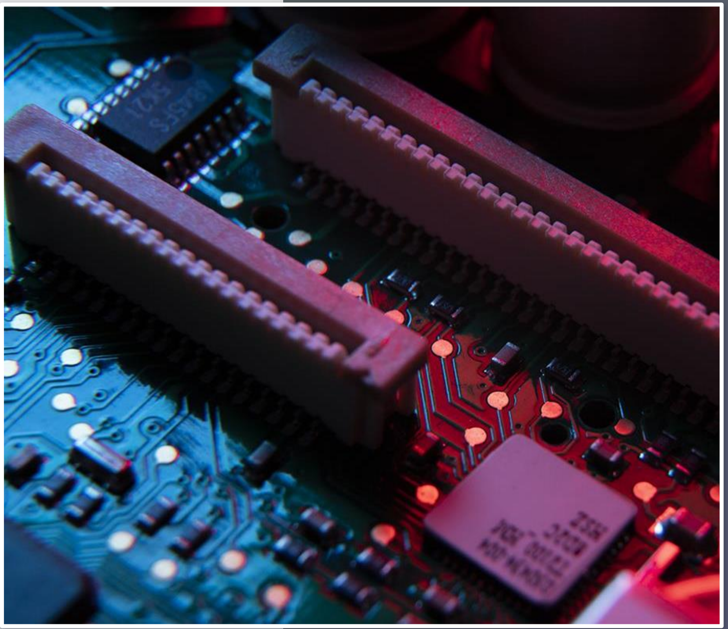
Introduction to Electronic Devices & Circuits

EDC101 Chapter 1



Introduction to Electronics Circuits

Electronics is the branch of science and engineering dealing with the theory and use of a class of devices in which electrons are transported through a vacuum, gas, or semiconductor.

It is also deals with electrical circuits that involve active electrical components such as vacuum tubes, transistors, diodes and integrated circuits, and associated passive electrical components and interconnection technologies.

Development of Electronics

01

Vacuum diode

Invented by **J.A. Fleming**, in 1897

02

Vacuum triode

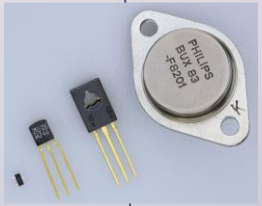
Implemented by **Lee De Forest** to amplify electrical signals

03

Tetrode and pentode tubes

Dominated the world until the **World War II**.

04

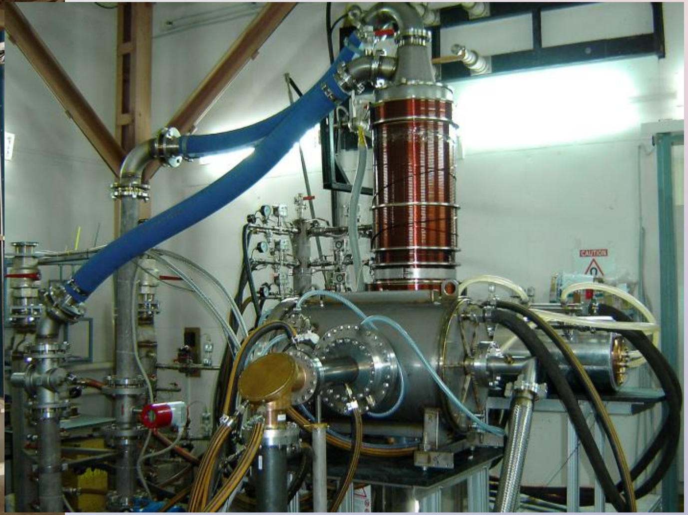


Junction Transistor

Transistor era began with the junction transistor invention in 1948

transistor-based computer

Transistor-based computer

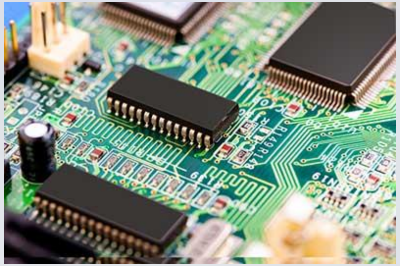


Bulky vacuum tubes

Development of Electronics

05

Integrated Circuits (ICs)



Drastically changed the electronic circuits' nature

The years 1958 to 1975 marked the introduction of IC with enlarged capabilities of over several thousand components on a single chip

06

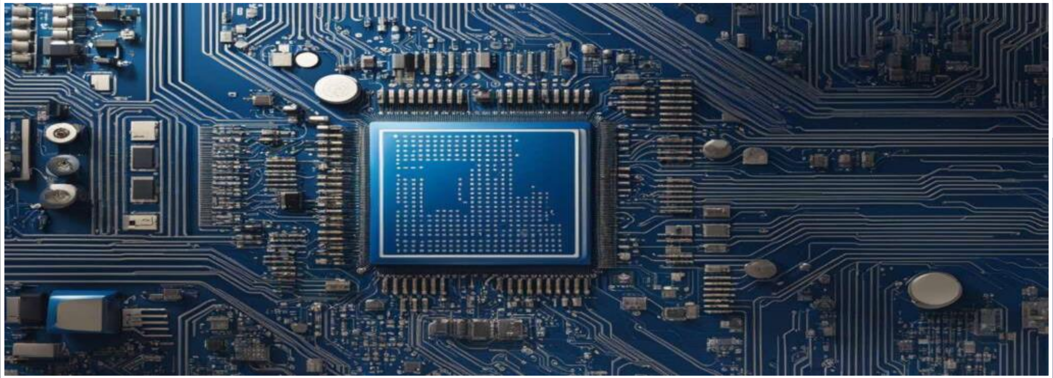
ICs were developed with Transistor-transistor logic **(TTL),** integrated injection logic **(I2L)** and emitter coupled logic (**ECL**) technologies

07

Later these digital ICs employed **PMOS, NMOS, and CMOS** fabrication design technologies

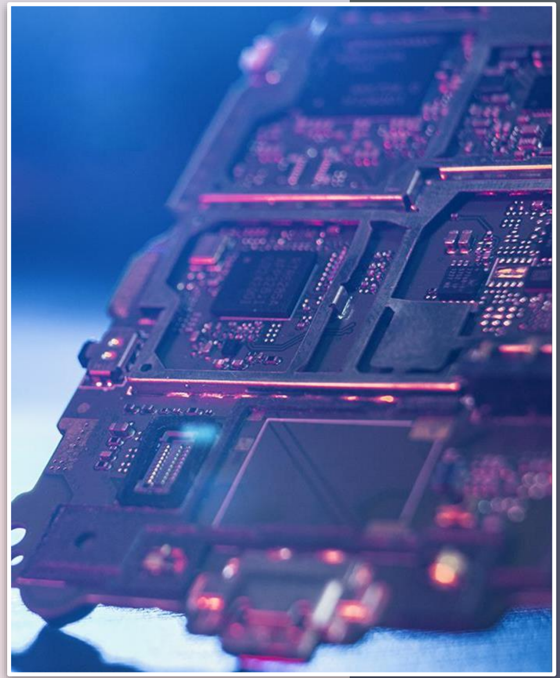
All these radical changes in all these components led to the introduction of microprocessor in 1969 by Intel.

Soon after, the analog integrated circuits were developed that introduced an operational amplifier for an analog signal processing. These analog circuits include analog multipliers, ADC and DAC converters and analog filters.



Can you imagine life without any electronic appliances in your home? Wouldn’t it be hard to do things around without them?

— **Applications of electronics**



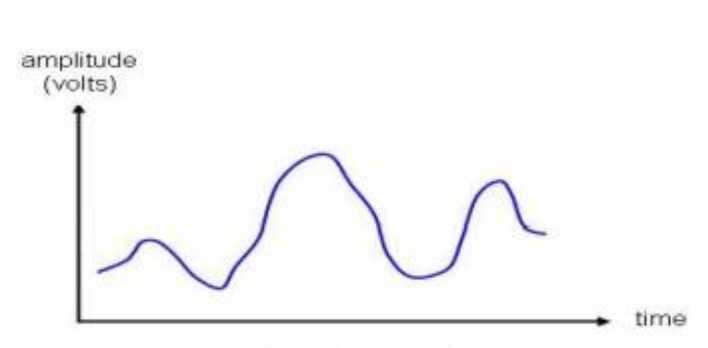
Signals:

It contains information about a variety of things and activities.

Example - Voice of the radio announcer, weather information

Analog Signal

The signal magnitude can be represented at any instant of time by a sequence of numbers.



a) analog signal

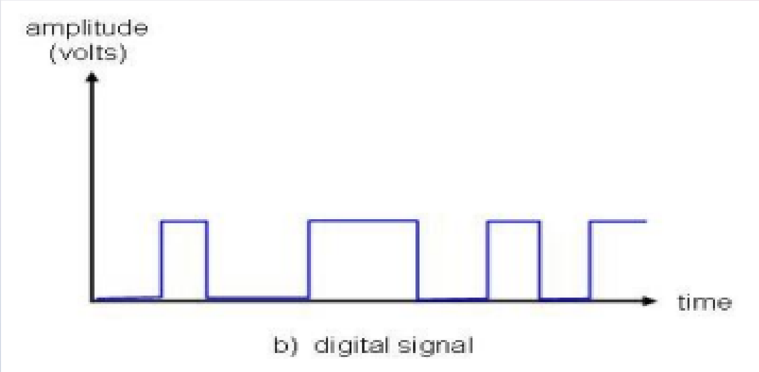
Signals:

It contains information about a variety of things and activities.

Example - Voice of the radio announcer, weather information

Discrete Signal

It is a sequence of numbers that represent the magnitudes of the successive signal samples.

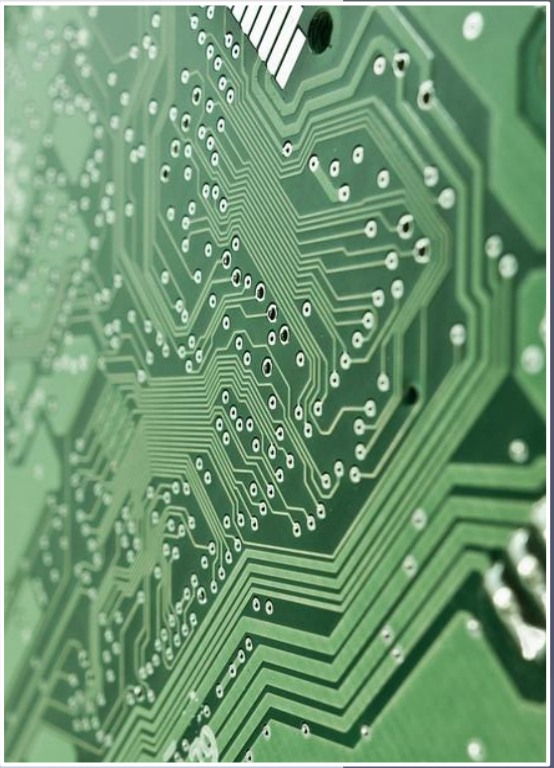


Digital Signal - Signal is in the form of 0 and 1.

What is Electronic Circuit?

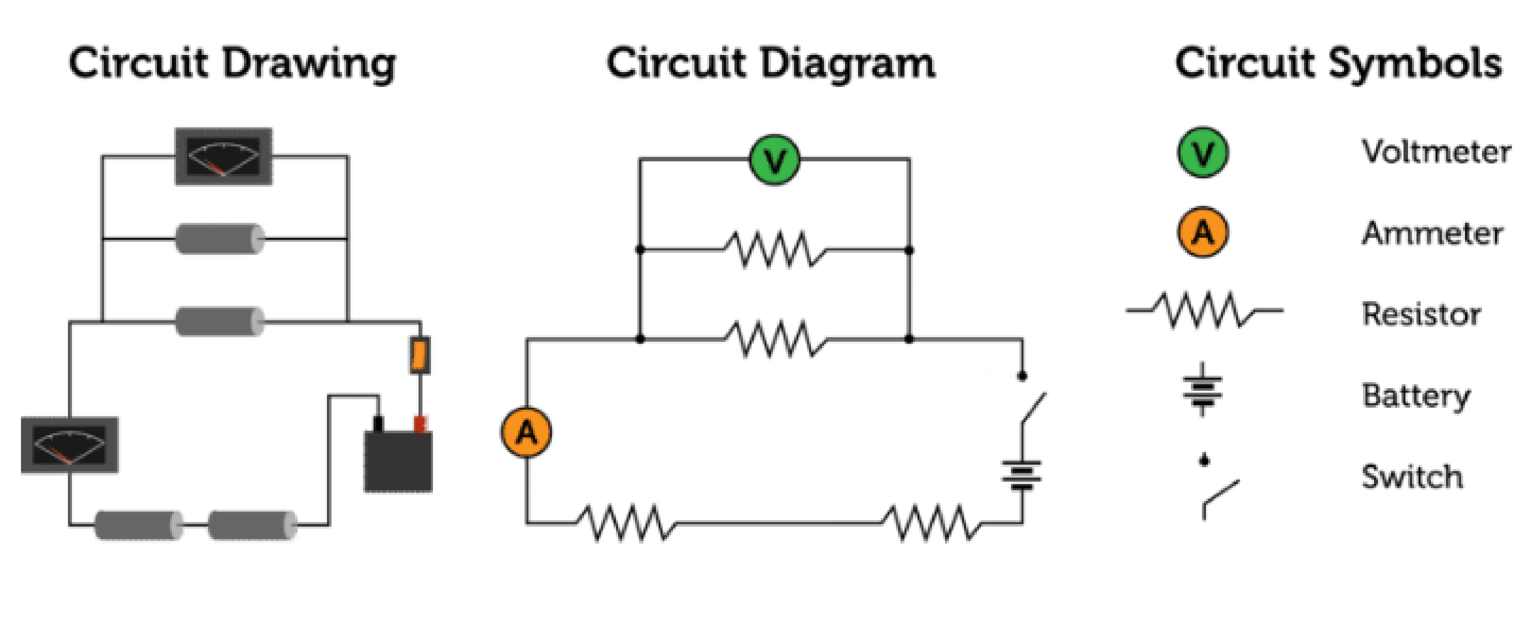
An electronic circuit is a complete course of conductors through which current can travel. Circuits provide a path for current to flow.

An electronic circuit is composed of individual electronic components, such as resistors, transistors, capacitors, inductors and diodes, connected by conductive wires or traces through which electric current can flow. To be referred to as electronic, rather than electrical, generally at least one active component must be present.

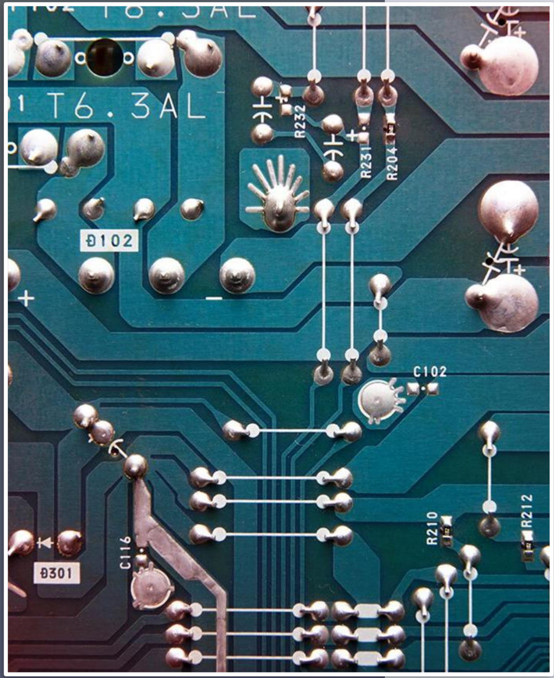


What is Circuits?

- Combination of electronic parts, wires connected between power sources. It's like a physical program. It's also like setting up dominoes in sequence.



Circuit Diagram



01

Basic Elements of Electronic Circuits

All complete circuits must have the following components:

Voltage Source

A voltage source causes current to flow like a battery, for instance.

The load consumes power; it represents the actual work done by the circuit. Without the load, there's not much point in having a circuit.

Load

This provides a route through which current flows. This route begins at the voltage source, travels through the load, and then returns to the voltage source. This path must form a loop from the negative side of the voltage source to the positive side of the voltage source

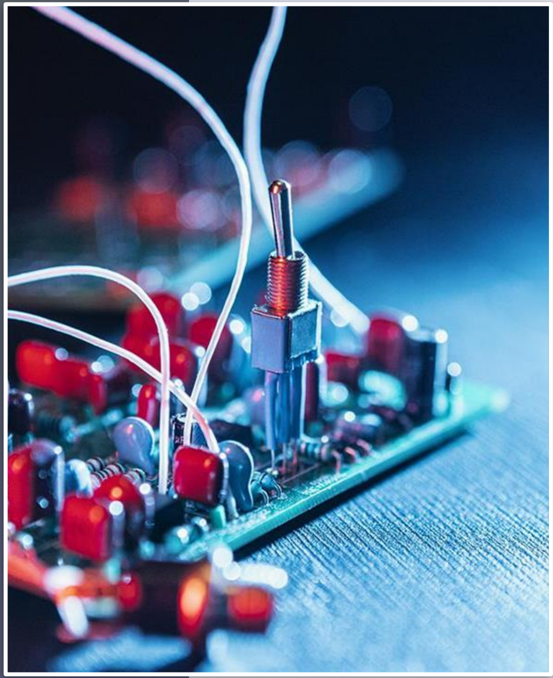
Conductive Path

Are components that provide management inside the circuit at specific times or sequences

Controllers

02

Types of Electronic Circuits

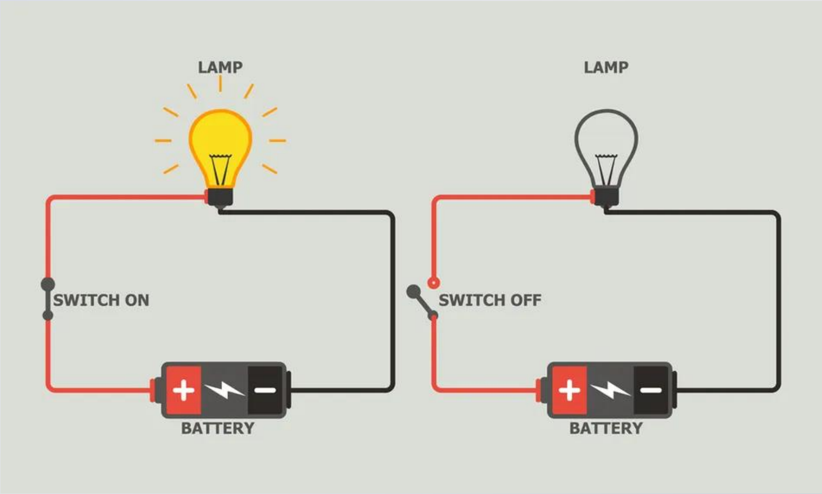


In order for a **circuit to work**, all three elements must be integrated or connected with each other in a **closed loop**. Everything starts and ends in the same place; no disconnections, interruptions, or dead-ends. However, there are some circuits that intentionally do not form a loop. These are known as open circuits, which is one type of circuit.

Types of Electronic Circuits

Closed Circuit

- This is the most common type of circuit. All components are connected to form one uninterrupted loop which may or may not perform a function, depending on the situation.



Open Circuit

A circuit that does not form a loop. One or more electronic components are disconnected either intentionally (like how a light switch turns a light bulb on and off) or accidentally.

Types of Electronic Circuits

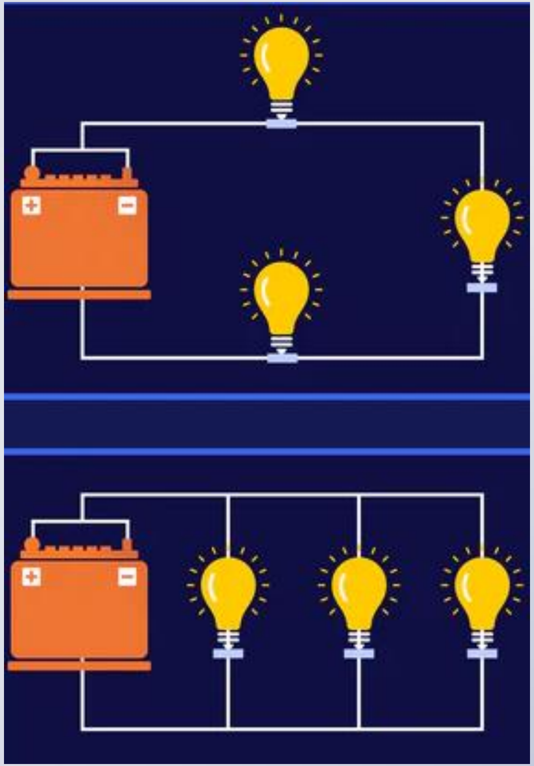
Short Circuit

A short circuit happens when two points in an electric circuit form a low-resistance connection. The current typically prefer this new pathway over the intended route, which can, in turn, throw the circuit’s function off-balance. This is why short circuits are often equated to serious or damaging issues in electronic equipment (like batteries exploding or fuse boxes malfunctioning).

Types of Electronic Circuits

Series Circuit

A series circuit is a circuit in which load are arranged in a chain, so the current has only one path to take. The current is the same through each resistor.



Parallel Circuit

A parallel circuit is a circuit in which the load is arranged with their heads connected together, and their tails connected together. The current in a parallel circuit breaks up, with some flowing along each parallel branch and re-combining when the branches meet again. The voltage across each resistor in parallel is the same.

An electronic component is **any basic discrete device** or **physical entity** in an electronic system used to affect electrons or their associated fields. Electronic components are mostly industrial products, available in a singular form and are not to be confused with electrical elements, which are conceptual abstractions representing idealized electronic components. Electronic components have a number of electrical terminals or leads. These leads connect to other electrical components, often over wire, to create an electronic circuit with a particular function.

Electronic Components

Classification of Components

01

Active Components

rely on a source of energy (usually from the DC circuit, which we have chosen to ignore) and usually can inject power into a circuit, though this is not part of the definition.

02

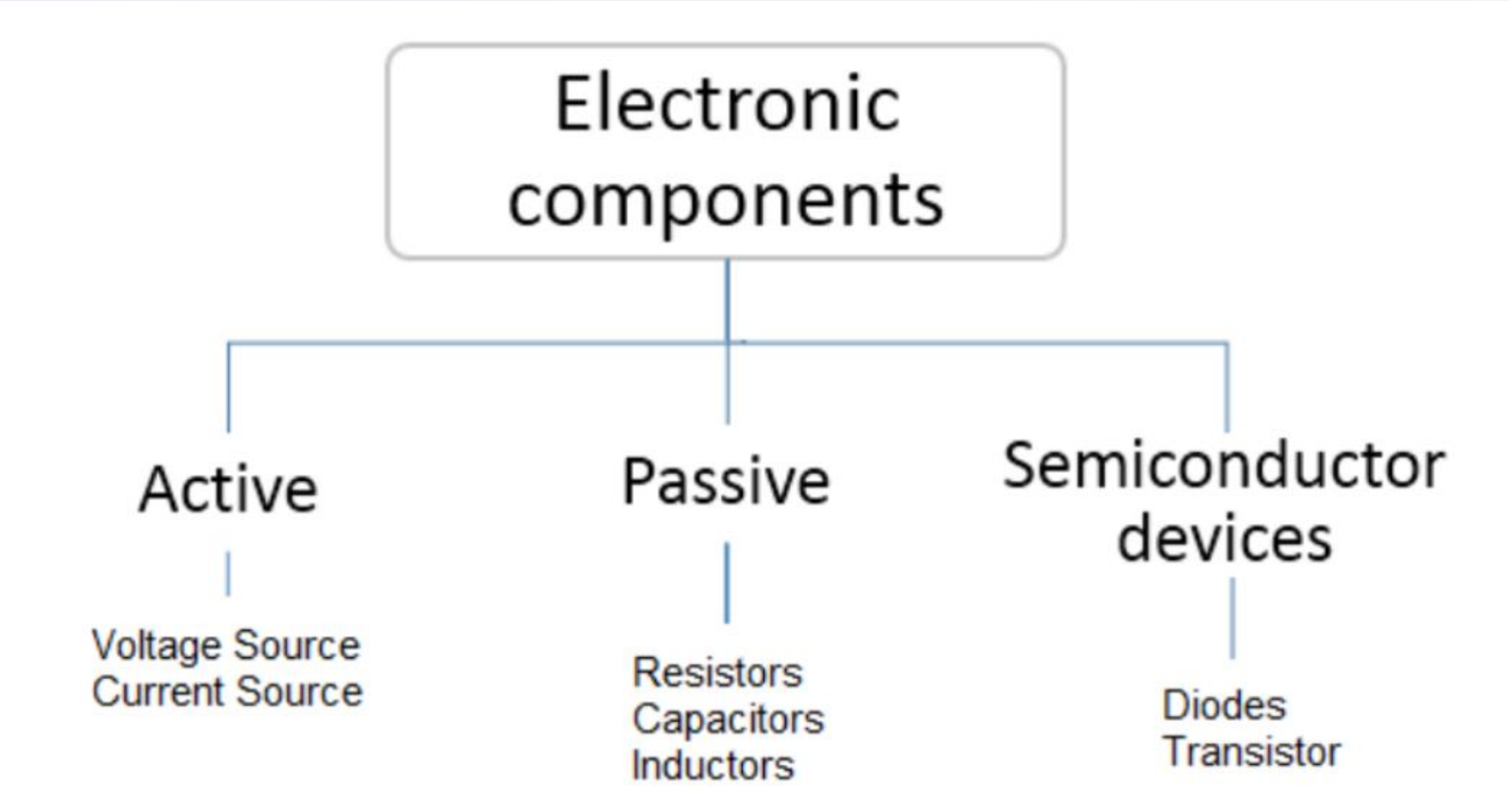
Passive Components

cannot introduce net energy into the circuit. They also cannot rely on a source of power, except for what is available from the (AC) circuit they are connected to.

03

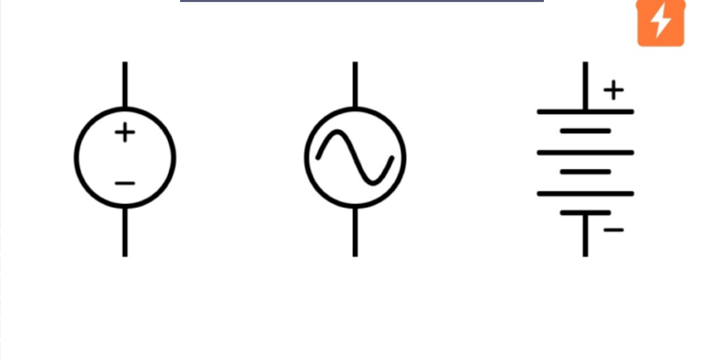
Semiconductor

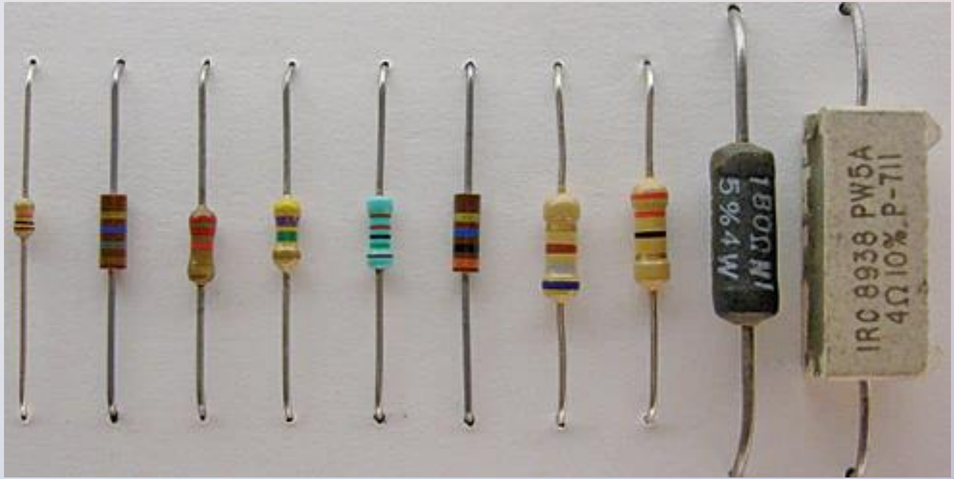
materials which have a conductivity between conductors (generally metals) and non-conductors or insulators (such as ceramics).


Electronic components
Active
Passive
Semiconductor devices
Voltage Source
Current Source
Resistors
Capacitors
Inductors
Diodes
Transistor

Examples of Electronic Components

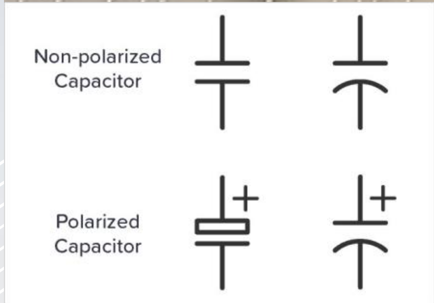
Current/Voltage Sources



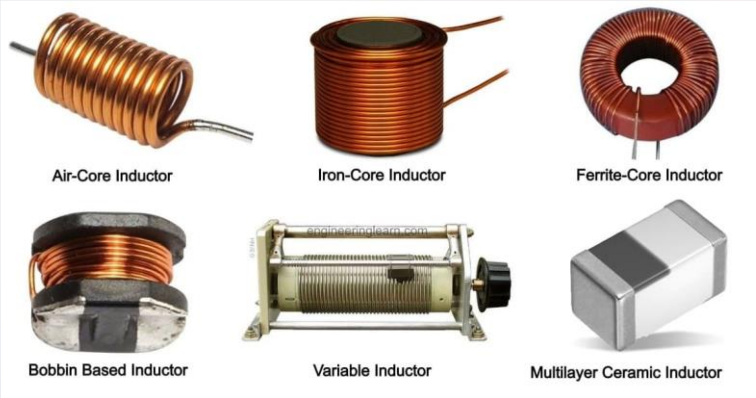


Resistors

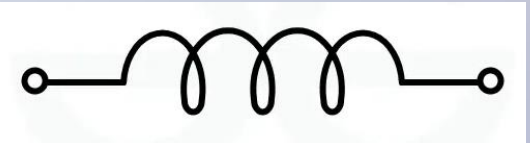
Examples of Electronic Components



Capacitors

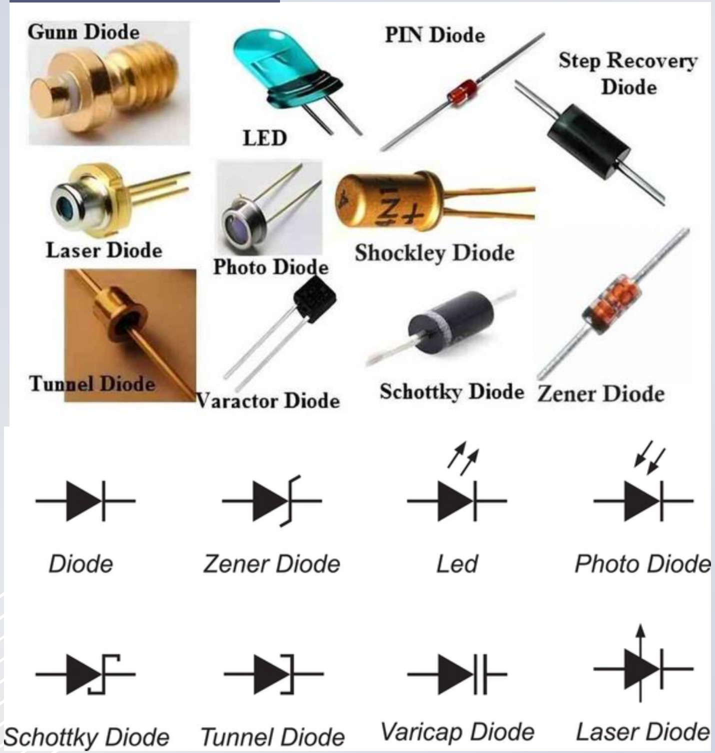


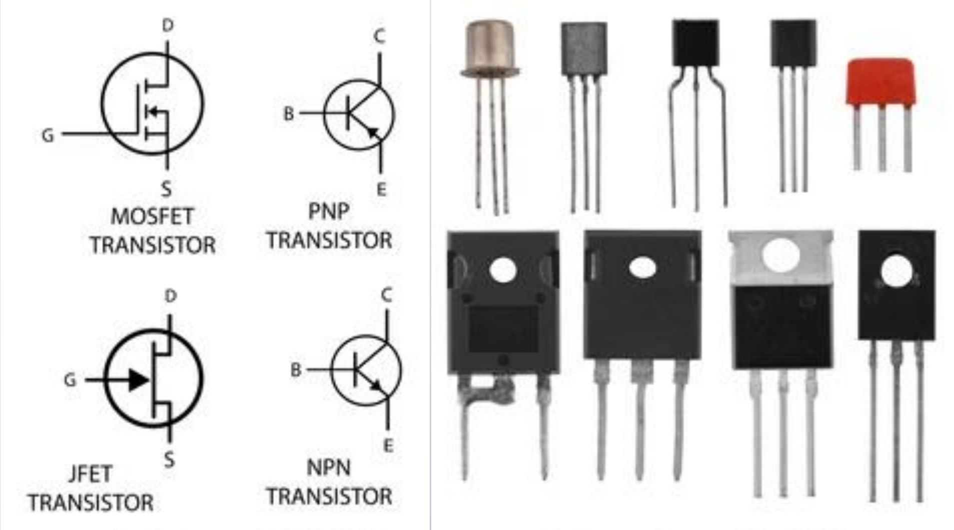
Inductors



Examples of Electronic Components

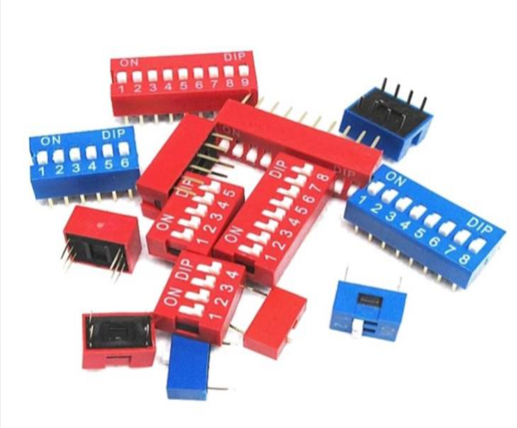
Diodes



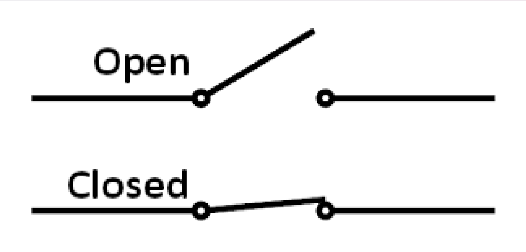


Transistors

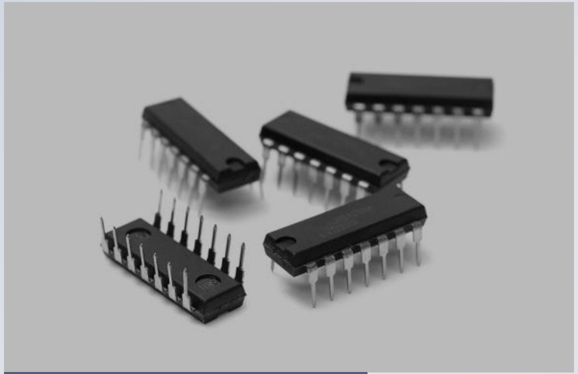
Examples of Electronic Components



Switches



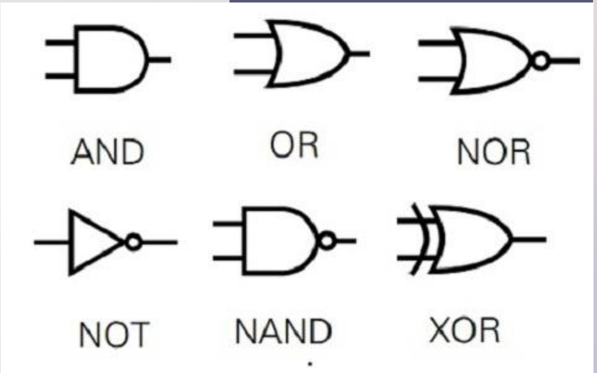
Other Electronic Components



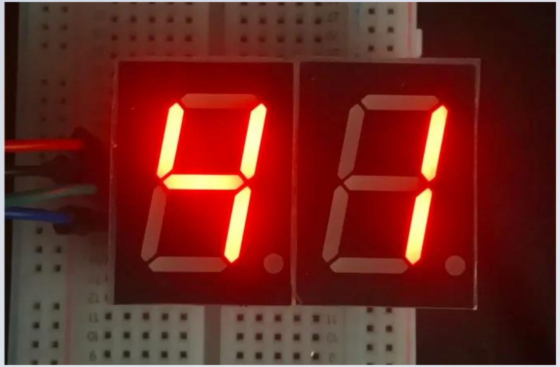
Integrated Circuits (ICs)

Programmable Integrated Circuit (PIC)

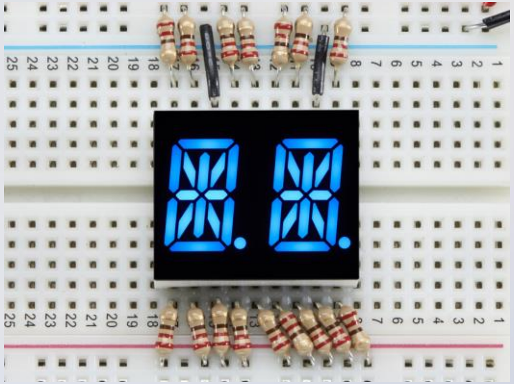
Basic Logic Gates



Other Electronic Components

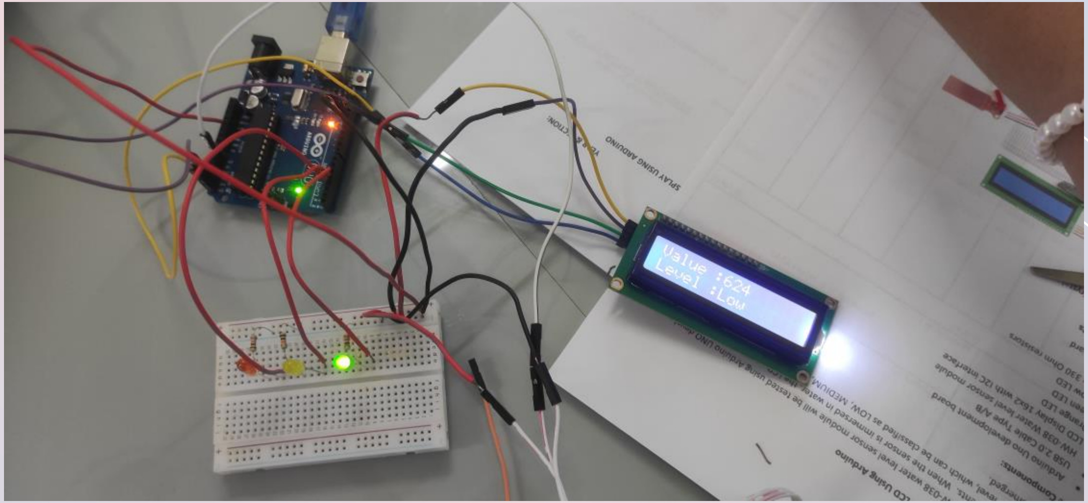


Seven Segment Display

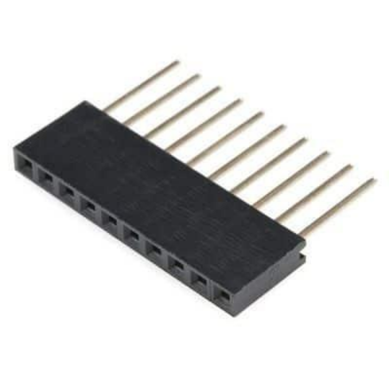


Alphanumeric Display

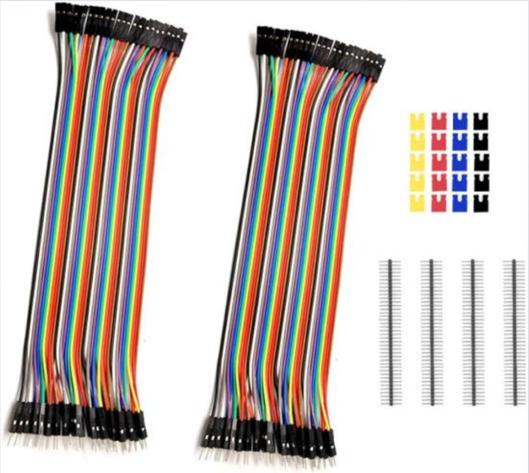
LCD Display


Value :624
Level :Low

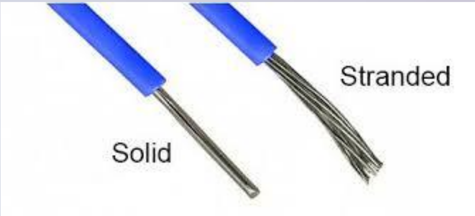
Electronic Components Accessories



Pin Headers

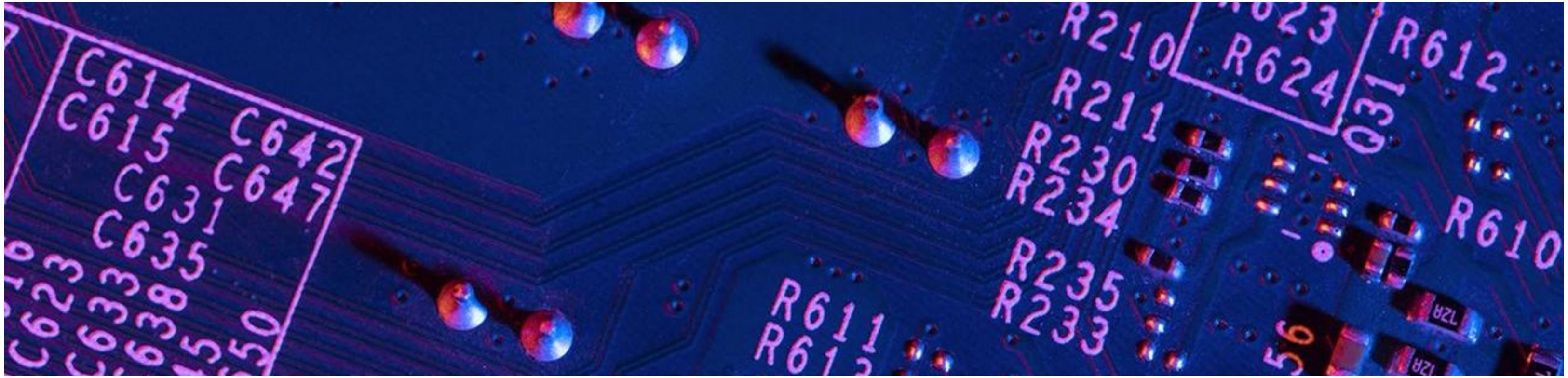


Connectors



Wires

Analog Vs Digital

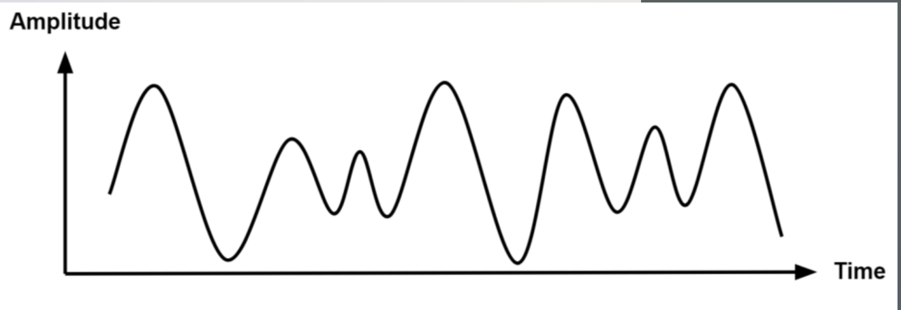


Analog Signals vs Digital Signals

A signal is an **electromagnetic or electrical current** that **carries data** from one system or network to another. In electronics, a signal is often a time varying voltage that is also an electromagnetic wave carrying information, though it can take on other forms, such as current. There are two main types of signals used in electronics: analog and digital signals.

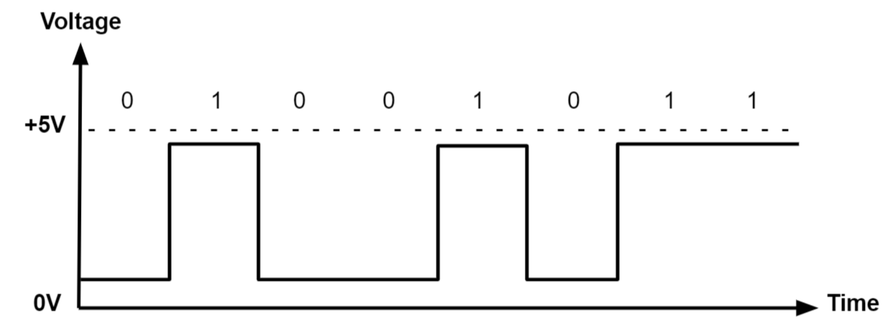
The difference between analog and digital technologies is that in **analog technology**, information is translated **into electric pulses of varying amplitude**. In **digital technology**, translation of information is into **binary format (zero or one)** where each bit is representative of **two distinct amplitudes**.

Analog Signal



An analog signal is *time-varying* and generally bound to a range (e.g. +12V to -12V), but there is an infinite number of values within that *continuous range*. An analog signal uses a given property of the medium to convey the signal's information, such as *electricity moving through a wire*. In an electrical signal, the voltage, current, or frequency of the signal may be varied to represent the information. Analog signals are often calculated responses to changes in light, sound, temperature, position, pressure, or other physical phenomena.

Digital Signal

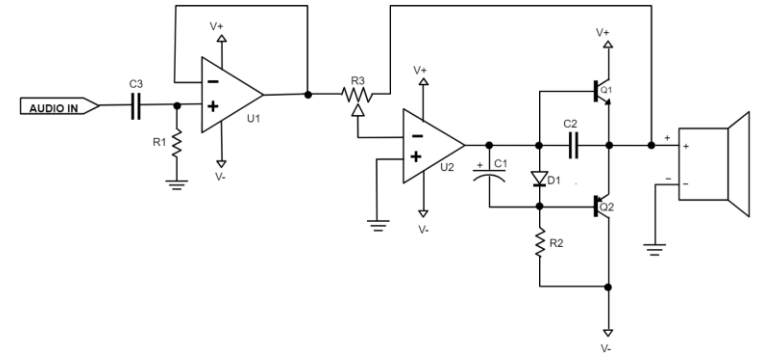


A signal that represents data as a *sequence of discrete values*. A digital signal *can only take on one value from a finite set of possible values at a given time*. With digital signals, the physical quantity representing the information can be many things:

- Variable electric current or voltage
- Phase or polarization of an electromagnetic field
- Acoustic pressure
- The magnetization of a magnetic storage media

Digital signals are used in all digital electronics, including computing equipment and data transmission devices.

Analog Electronics



Most of the fundamental electronic components — resistors, capacitors, inductors, diodes, transistors, and operational amplifiers (op amps) — are all inherently analog components. Circuits built with a combination of these components are analog circuits

Analog circuits are usually more susceptible to noise, with “noise” being any small, undesired variations in voltage. Small changes in the voltage level of an analog signal can produce significant errors when being processed.

Analog Electronics

Analog signals are commonly used in communication systems that convey voice, data, image, signal, or video information using a continuous signal. There are two basic kinds of analog transmission, which are both based on how they adapt data to combine an input signal with a carrier signal. The two techniques are **amplitude modulation** and **frequency modulation**.

Amplitude Modulation (AM)

Adjusts the amplitude of the carrier signal

Frequency Modulation (FM)

Adjusts the frequency of the carrier signal

Analog transmission may be achieved via many methods:

01

Through a twisted pair or coaxial cable

02

Through an optical fiber cable

03

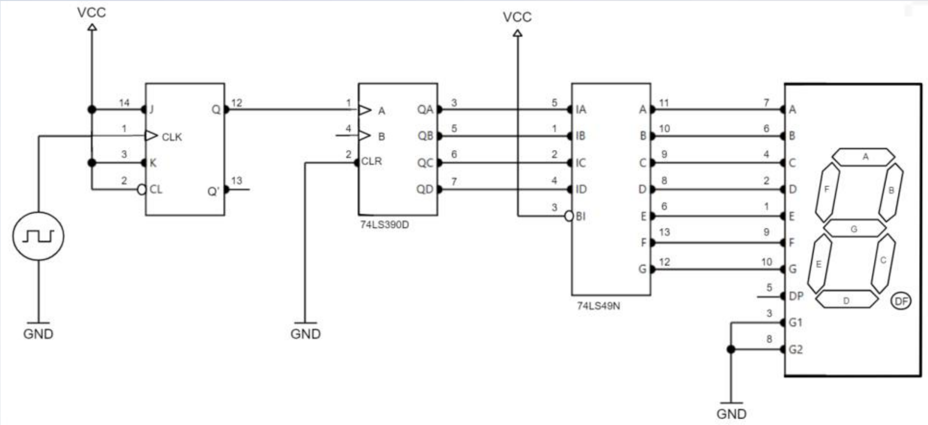
Through radio

04

Through water

Digital Electronics

Digital circuits implement components such as logic gates or more complex digital ICs. Such ICs are represented by rectangles with pins extending from them.



Unlike analog circuits, most useful digital circuits are *synchronous*, meaning there is a reference clock to coordinate the operation of the circuit blocks, so they operate in a predictable manner. Analog electronics operate asynchronously, meaning they process the signal as it arrives at the input.

Digital Electronics

Digital signals are commonly used in communication systems where digital transmission can transfer data over point-to-point or point-to-multipoint transmission channels, such as *copper wires*, *optical fibers*, *wireless communication media*, *storage media*, or *computer buses*. The transferrable data is represented as an electromagnetic signal, such as a microwave, radio wave, electrical voltage, or infrared signal.

Properties of Digital vs Analog Signals

01

Synchronization

digital communication uses specific synchronization sequences for determining synchronization.

02

Language

digital communications requires a language which should be possessed by both sender and receiver and should specify meaning of symbol sequences.

Properties of Digital vs Analog Signals

03

Errors

– disturbances in analog communication causes errors in actual intended communication but disturbances in digital communication does not cause errors enabling error free communication. Errors should be able to substitute, insert or delete symbols to be expressed.

Copying – analog communication copies are quality wise not as good as their originals while due to error free digital communication, copies can be made indefinitely.

Granularity – for a continuously variable analog value to be represented in digital form there occur quantization error which is difference in actual analog value and digital representation and this property of digital communication is known as granularity.

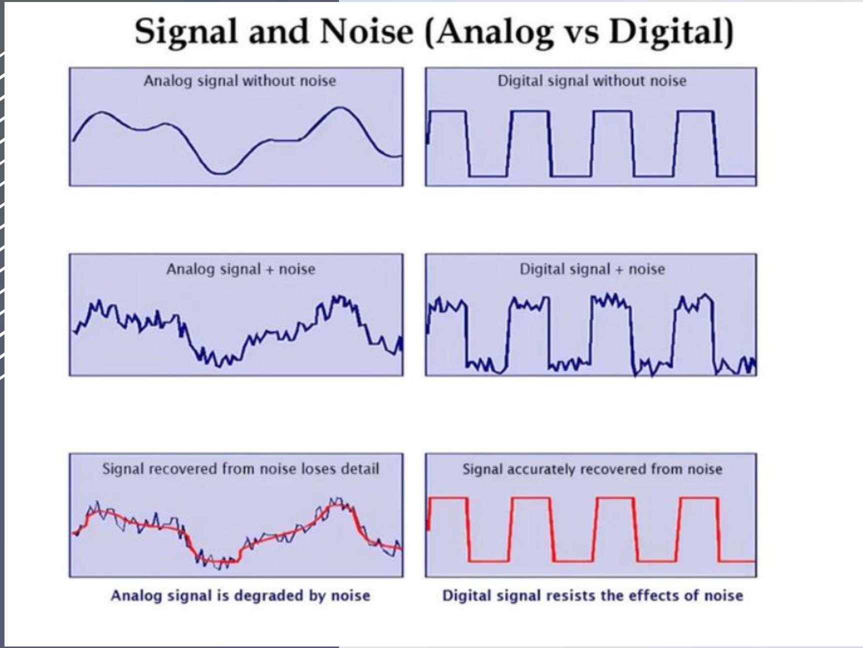
ANALOG VS. DIGITAL DEVICES AND CIRCUITS

Accuracy

Analog: More accurate for capturing real-world nuances because they represent exact variations in input signals.

Digital: Limited to fixed steps but more reliable because they can ignore small distortions or noise.

ANALOG VS. DIGITAL DEVICES AND CIRCUITS

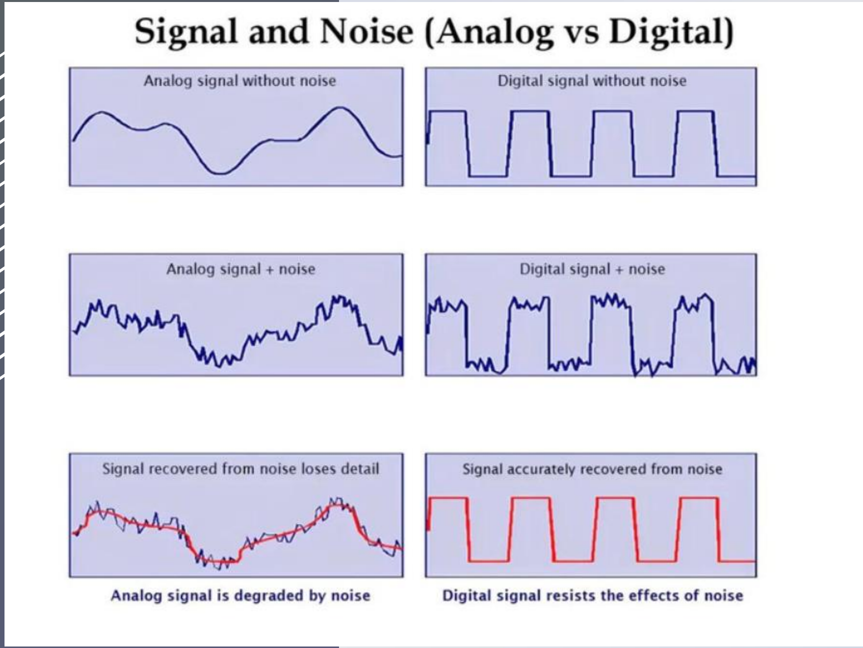


Noise Susceptibility

Analog: More prone to interference (like static on a radio).

Digital: Resistant to noise because slight variations don’t affect whether a signal is read as a 1 or 0.

ANALOG VS. DIGITAL DEVICES AND CIRCUITS



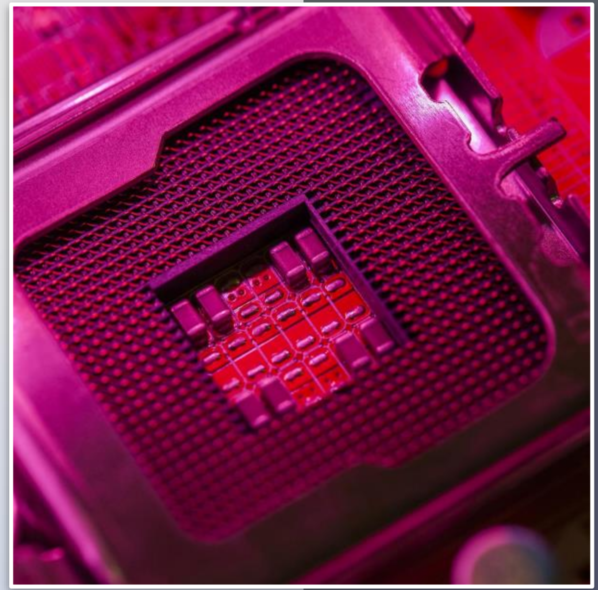
Use Cases

Analog: Best for applications that require processing of real-world, continuous signals, such as audio recording.

Digital: Ideal for computing and storing precise data, such as in computers and smartphones.

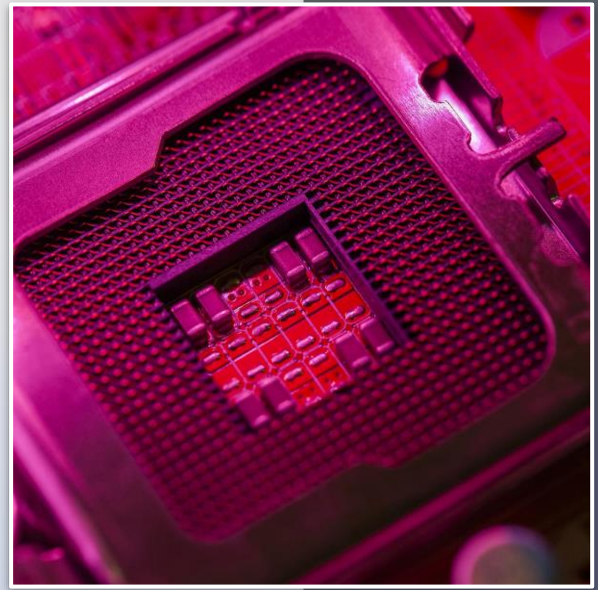
Differences in Usage in Equipment

Many devices come with built in translation facilities from analog to digital. Microphones and speaker are perfect examples of analog devices. **Analog technology** is cheaper but there is a limitation of size of data that can be transmitted at a given time.



Differences in Usage in Equipment

Digital technology has revolutionized the way most of the equipment's work. Data is converted into binary code and then reassembled back into original form at reception point. Since these can be easily manipulated, it offers a wider range of options. Digital equipment is more expensive than analog equipment.



Differences between Digital and Analog System

Sr. No.	Key	Digital System	Analog System
1	Signal Type	Digital System uses discrete signals as on/off representing binary format. Off is 0, On is 1.	Analog System uses continous signals with varying magnitude.
2	Wave Type	Digital System uses square waves.	Analog system uses sine waves.
3	Technology	Digital system first transform the analog waves to limited set of numbers and then record them as digital square waves.	Analog systems records the physical waveforms as they are originally generated.
4	Transmission	Digital transmission is easy and can be made noise proof with no loss at all.	Analog systems are affected badly by noise during transmission.
5	Flexibility	Digital system hardware can be easily modulated as per the requirements.	Analog system's hardwares are not flexible.

Differences between Digital and Analog System

Sr. No.	Key	Digital System	Analog System
6	Bandwidth	Digital transmission needs more bandwidth to carry same information.	Analog tranmission requires less bandwidth.
7	Memory	Digital data is stored in form of bits.	Analog data is stored in form of waveform signals.
8	Power requirement	Digital system needs low power as compare to its analog counterpart.	Analog systems consume more power than digital systems.
9	Best suited for	Digital system are good for computing and digital electronics.	Analog systems are good for audio/video recordings.
10	Cost	Digital system are costly.	Analog systems are cheap.

Differences between Digital and Analog System

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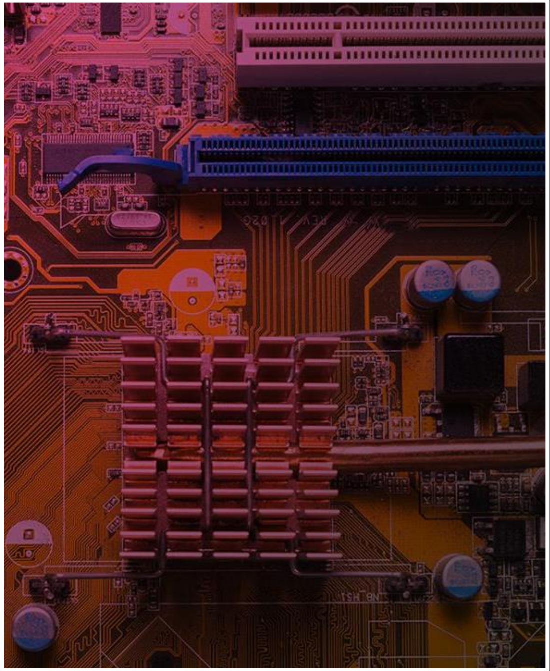
03

ROLE OF ELECTRONIC DEVICES IN IT & IOT



Role of Electronics Devices in IT

Embedded Systems: An embedded system is a small computer built into a larger device to perform dedicated functions. Microcontrollers (small, programmable chips) are often used in these systems.

Example: The CPU of a smartphone processes user inputs and manages the hardware (camera, display, sensors).

Role of Electronics Devices in IT

Computer Hardware:

Central Processing Unit (CPU): Acts as the brain of the computer, executing instructions and performing calculations.
Random Access Memory (RAM): Temporarily holds data that the CPU needs quick access to.
Motherboard Circuits: Connect all hardware components and provide a path for signals to flow.

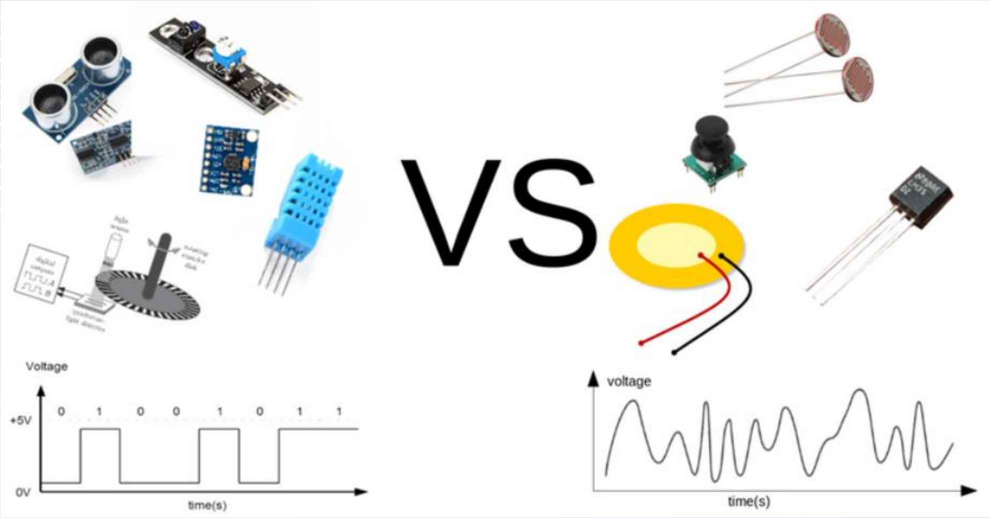
Role of Electronics Devices in IT

Network Hardware

Routers: Direct data traffic between devices and the internet.
Switches: Allow devices on the same network to communicate.
Modems: Convert digital data from your device into a format that can be transmitted over communication lines (like the internet).

Role of Electronics Devices in IoT

Sensors: Sensors collect data from the environment, such as temperature, pressure, or motion. They are the "eyes" and "ears" of an IoT system.



Analog Sensors: Continuously measure real-world parameters, like light or sound.

Digital Sensors: Provide binary output (on/off), like a digital thermometer that gives a specific number.

Role of Electronics Devices in IoT

IoT Architecture:

Sensors: Monitor conditions and gather data (e.g., motion sensors in security systems).

Microcontrollers: Process the sensor data and make decisions (e.g., turn off lights when no movement is detected).

Communication Modules: Transfer data wirelessly to other systems (e.g., Wi-Fi, Bluetooth modules).

Smart Homes: Devices such as smart lights and thermostats use sensors to adjust automatically based on user preferences.

Wearables: Smartwatches use health sensors to monitor heart rate, activity levels, and sleep patterns.

Impact of Electronic Devices on IT & IoT

Efficiency:

Automation

Electronic devices enable automation of repetitive tasks, improving efficiency in industries like manufacturing, healthcare, and IT.

Real-Time Data

IoT devices provide instant data about everything from machine performance to home energy usage, enabling quicker decisions.

Impact of Electronic Devices on IT & IoT

Data Processing

Cloud Computing

Electronic devices connect with cloud services to process large datasets remotely, allowing smarter, data-driven decisions.

Smart Services

IoT devices are part of services that react to real-time data, such as predictive maintenance (fixing machines before they break down) or personalized healthcare (monitoring vitals).

Impact of Electronic Devices on IT & IoT

Challenges

Power Consumption

Many IoT devices rely on batteries, so energy-efficient electronics are critical.

Security

As IoT devices collect and transmit data, they become vulnerable to hacking, making encryption and security essential.

END