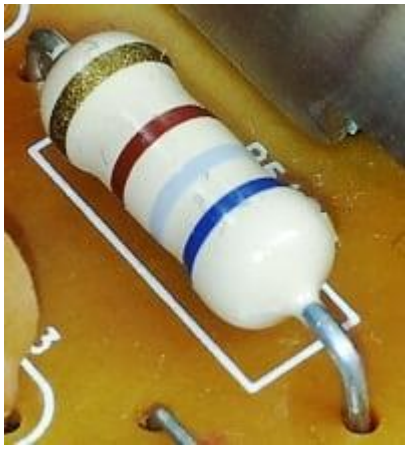
Rugved Task 1

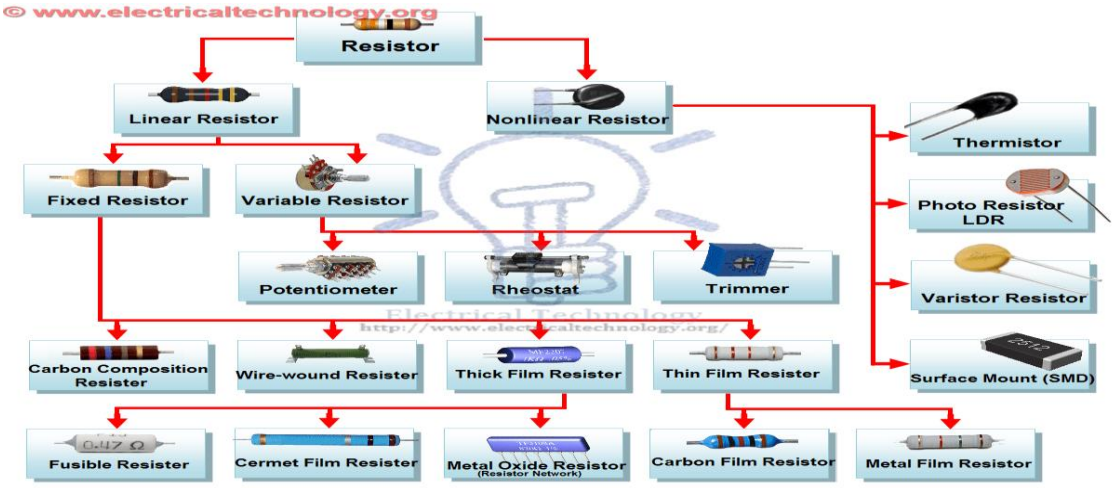
1] Resistors

Q. What is a Resistor?

A resistor can be defined as an electrical component that limits or regulates the flow of electrical current in an electronic circuit. It basically means that it is a device that creates resistance in the circuit to control the flow of current. It is a passive electrical component as it cannot produce electric power on its own.



Q. What are the various types of Resistors?



There are two major types of Resistors:-

1. Linear Resistors
2. Non-Linear Resistors

Linear Resistors:-

Resistors whose resistance increases linearly with applied voltage and temperature are called Linear Resistors. This means that current is directly proportional to voltage.

Non-Linear Resistors:-

As the name suggests, these are resistors whose current isn't linearly proportional to applied voltage.

1] Linear Resistors

Within Linear Resistors we have two sub types of Resistors:-

1. Fixed Resistors
2. Variable Resistors

Fixed Resistors:-

These are resistors which offers a specific value of resistance and doesn't change with change in voltage applied. They are compact, cheap and reliable as they come with a specific power and resistance rating.

Variable Resistors:-

These are resistors whose values can be changed through a dial, knob, and screw or manually by a proper method. In these types of resistors, there is a sliding arm, which is connected to the shaft and the value of resistance can be changed by rotating the arm. They are used in the radio receiver for volume control and tone control resistance

A} Fixed Resistors

Within Fixed Resistors we have 4 sub-groups:-

1. Carbon Composition Resistors
2. Wire Wound Resistors
3. Thin Film Resistors
4. Thick Film Resistors

1.Carbon Composition Resistors:-

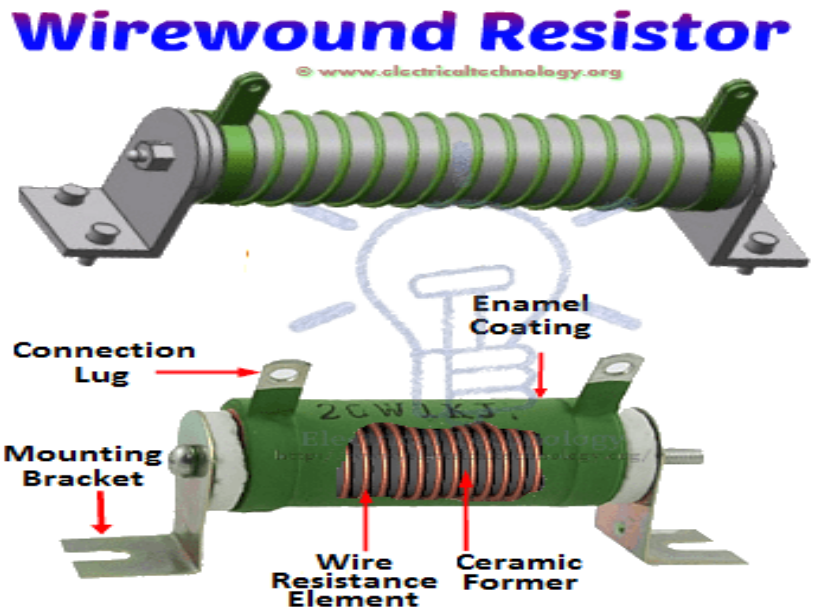
- They are a typical fixed resistor which is made from the mixture of granulated or powdered carbon or graphite, insulation filler, or a resin binder. The ratio of the insulation material determines the actual resistance of the resistor. The insulating powder (binder) made in the shape of rods and there are two metal caps on the both ends of the rod.

- These resistors normally have a power rating from ¼ to 5 watt and has a resistance rating from 1 ohm to 25 mega ohm.

2.Wire Wound Resistors:-

- Wire wound resistor is made from the insulating core or rod by wrapping around a resistive wire. The resistance wire is generally Tungsten, manganin, Nichrome or nickel or nickel chromium alloy and the insulating core is made of porcelain, Bakelite, press bond paper or ceramic clay material.
- The manganin wire wound resistors are very costly and used with the sensitive test equipment e.g. Wheatstone bridge, etc. They are available in the range of 2 watts up to 100 watt power rating or more. The ohmic value of these types of resistors is 1 ohm up to 200k ohms or more and can be operated safely up to 350°C. In addition, the power rating of a high power wire wound resistor is 500 Watts and the available resistance value of these resistors are is 0.1 ohm – 100k Ohms.

- Wire wound resistors used where high sensitivity, accurate measurement and balanced current control is required, e.g. as a shunt with ampere meter.



3.Thin Film Resistors:-

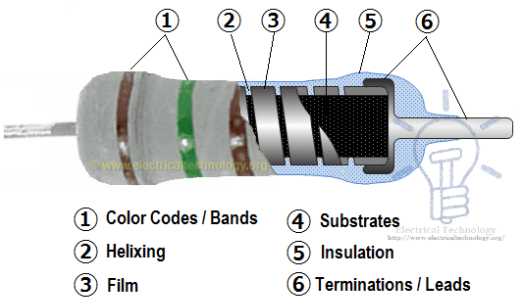
All thin film resistors are made of from high grid ceramic rod and a resistive material. A very thin conducting material layer overlaid on insulating rod, plate or tube which is made from high quality ceramic material or glass. There are two further types of thin film resistors.

There are two types of Thin Film Resistors:-

1. Carbon Film Resistors
2. Metal Film Resistors

(i)Carbon Film Resistors-

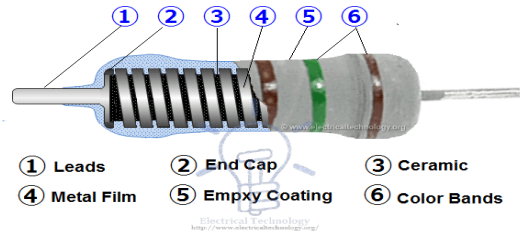
Carbon Film resistors contains on an insulating material rod or core made of high grade ceramic material which is called the substrate. A very thin resistive carbon layer or film overlaid around the rod. These kinds of resistors are widely used in electronic circuits because of negligible noise and wide operating range and the stability as compared to solid carbon resistors.



Carbon Film Resistors

(ii)Metal Film Resistors:-

Metal film resistors are same in construction like Carbon film resistors, but the main difference is that there is metal (or a mixture of the metal oxides, Nickel Chromium or mixture of metals and glass which is called metal glaze which is used as resistive film) instead of carbon. Metal film resistors are very tiny, cheap and reliable in operation. Their temperature coefficient is very low (±2 ppm/°C) and used where stability and low noise level is important.



Metal Film Resistors

4.Thick Film Resistors:-

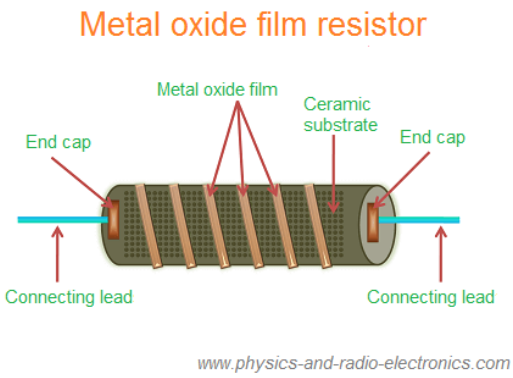
The production method of Thick film resistors is same like thin film resistors, but the difference is that there is a thick film instead of a thin film or layer of resistive material around. That's why it is called Thick film resistors.

There are two additional types of thick film resistors:-

1. Metal Oxide Resistors
2. Cermet Oxide Resistors
3. Fusible Resistors

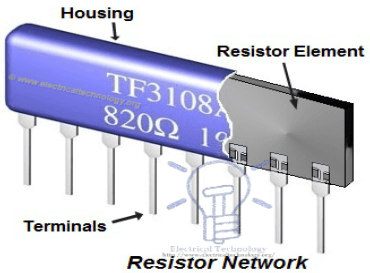
(i)Metal Oxide Resistor: -

By oxidizing a thick film of Tin Chloride on a heated glass rod (substrate) is the simple method to make a Metal oxide Resistor. These resistors are available in a wide range of resistance with high temperature stability. In addition, the level of operating noise is very low and can be used at high voltages.



(ii)Cermet Oxide Resistor (Network Resistor):-

In the cermet oxide resistors, the internal area contains on ceramic insulation materials. And then a carbon or metal alloy film or layer wrapped around the resistor and then fix it in a ceramic metal (which is known as Cermet). They are made in the square or rectangular shape and leads and pins are under the resistors for easy installation in printed circuit boards. They provide a stable operation in high temperature because their values do not change with change in temperature.



Cermet Film Resistor

(iii)Fusible Resistor:-

These kinds of resistors are same like a wire wound resistor. When a circuit power rating increased than the specified value, then this resistor is fused, i.e. it breaks or open the circuit. That's why it is called Fusible resistors. Fusible restores perform double jobs means they limit the current as well as it can be used as a fuse.

They used widely in TV Sets, Amplifiers, and other expensive electronic circuits. Generally, the ohmic value of fusible resistors is less than 10 Ohms.

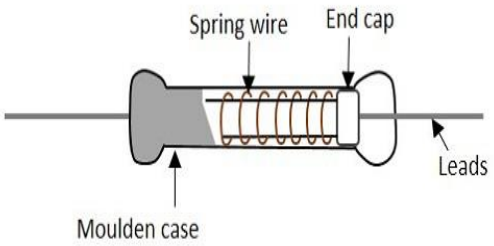


Image of a Fusible resistor

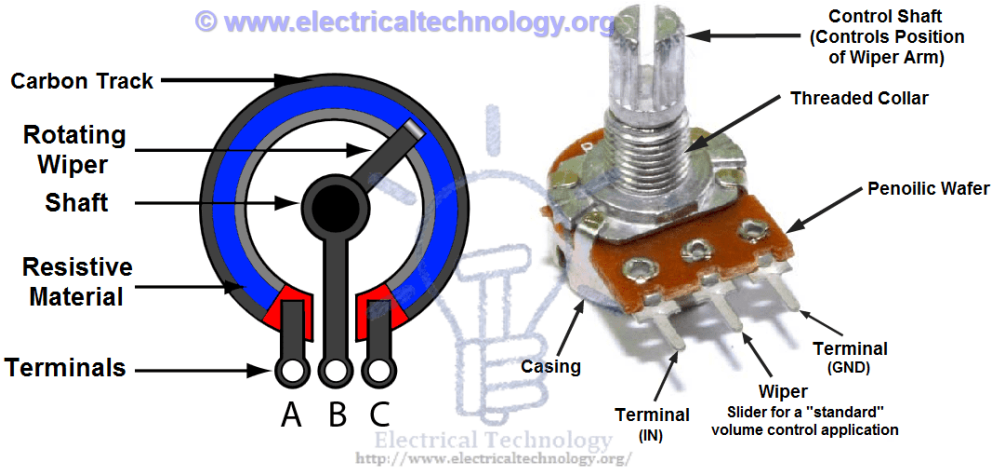
B} Variable Resistors

There are three types of variable resistors:-

1. Potentiometers
2. Rheostats
3. Trimmers

(i)Potentiometers:-

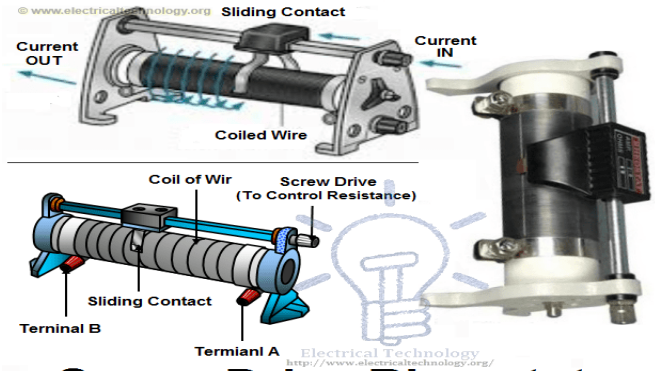
Potentiometer is a three terminal device which is used for controlling the level of voltage in the circuit. The resistance between two external terminals is constant while the third terminal is connected with moving contact (Wiper) which is variable. The value of resistance can be changed by rotating the wiper which is connected to the control shaft.



Potentiometer Construction

(ii)Rheostat:-

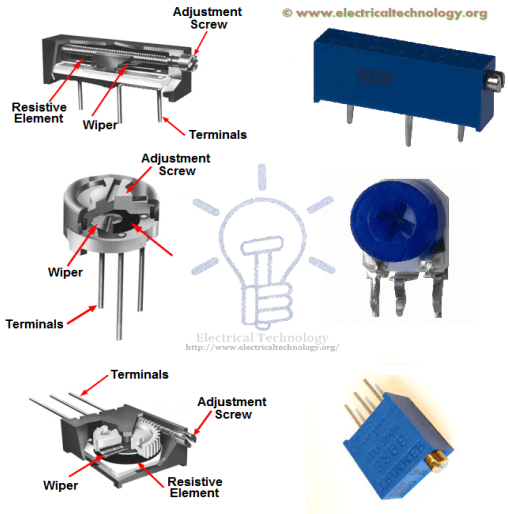
Rheostats are a two or three terminal device which is used for the current limiting purpose by hand or manual operation. Rheostats are also known as tapped resistors or variable wire wound resistors.
Variable wire wound resistors are available in the range of 1 ohm up to 150 Ohms. The available power rating of these resistors is 3 to 200 Watts. While the most used Rheostats according to power rating is between 5 to 50 Watts.



Screw Drive Rheostat

(iii)Trimmers:-

There is an additional screw with Potentiometer or variable resistors for better efficiency and operation and they are known as Trimmers. The value of resistance can be changed by changing the position of screw to rotate by a small screwdriver.
They are made from carbon composition, carbon film, cermet, and wire materials and available in the range of 50 Ohms up to 5 mega ohms. The power rating of Trimmers potentiometers are from 1/3 to ¾ Watts.



Trimmer Construction

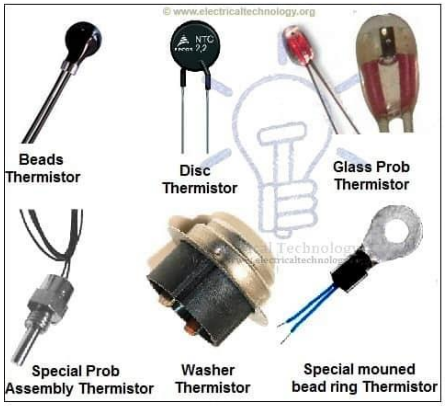
2] Non-Linear Resistors

There are three types of non-linear resistors:-

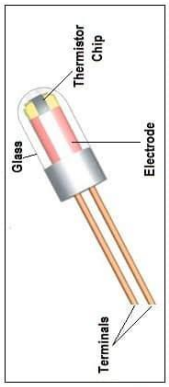
1. Thermistors
2. Varisters (VDR)
3. Photo Resistor or Photo Conductive Cell or LDR

(i)Thermistors:-

Thermistors is a two terminal device which is very sensitive to temperature. In other words, Thermistors is a type of variable resistor which notices the change in temperature. Thermistors are made from the cobalt, Nickel, Strontium and the metal oxides of Manganese. The Resistance of a Thermistor is inversely proportional to the temperature, i.e. resistance increases when temperature decrease and vice versa.



Types of Thermistor



Construction of Thermistor

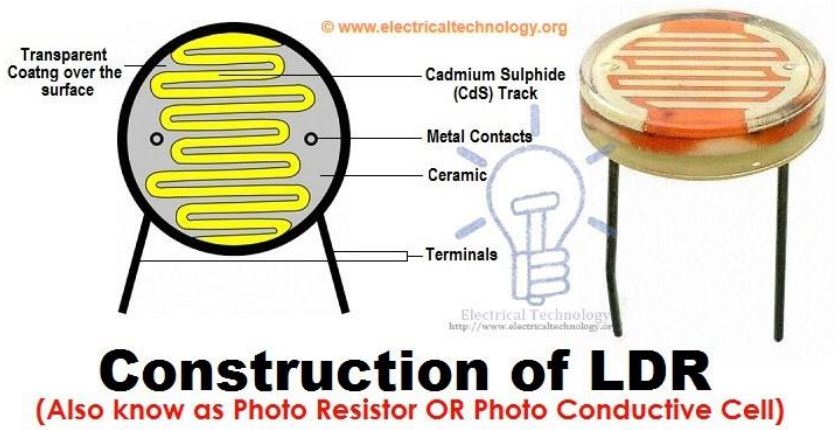
(ii)Varisters:-

Varisters are voltage dependent Resistors (VDR) which is used to eliminate the high voltage transients. In other words, a special type of variable resistors used to protect circuits from destructive voltage spikes is called Varisters.
When voltage increases (due to lighting or line faults) across a connected sensitive device or system, then it reduces the level of voltage to a secure level i.e. it changes the level of voltages.

Types of Varister

(iii)Photo-Resistors:-

Photo Resistor or LDR (Light Dependent Resistors) is a resistor which terminal value of resistance changes with light intensity. In other words, those resistors, which resistance values changes with the falling light on their surface is called Photo Resistor or Photo Conductive Cell or LDR (Light Dependent Resistor). The material which is used to make these kinds of resistors is called photo conductors, e.g. cadmium sulfide, lead sulfide etc.



Q] What are some applications of Resistors?

Some applications and uses of resistor are listed below:

- Circuit functions
- Dividing voltage
- Heating
- Frequency and timing
- LEDs and transistor

(i)Resistor usage in Circuit Functions

There are various types of resistors that work according to the usage range. In that, we can set the resistance by using a knob kind of feature. Changing resistance will affect the flow of current inside the circuit. For example, this type of resistor is used in controlling the speed of a motor, pitch of a musical tone, loudness of an amplifier, etc.

(ii)Resistor is used for Diving Voltage

Dividing the voltage works when some components need to work in a much lesser voltage than the supplied input voltage. Connecting the resistors in a series will help to drop the voltage across each resistor equally, thus, assisting the appliances smoothly which works in those conditions.

(iii)It is also used for Heating

Because of the nature of generating heat when conducting current, resistors are used in a heater, toaster, microwave, electric stove, and many more heating appliances. In a light bulb, the metal filament glows white-hot due to the very high temperature produced from the resistance when electricity is passed through it.

(iv)Uses of Resistor to function in particular Timing and at a certain Frequency

Like in a light flasher, electronic sirens, blinking lights used in airplanes or tall towers which acts as a collision avoidance measure. They work on the principle of filling up current to a certain time and then discharge light, in here, the resistor decides how much current has to be passed according to the time allotted. If resistance increases, the time for discharging current in the circuit increases.

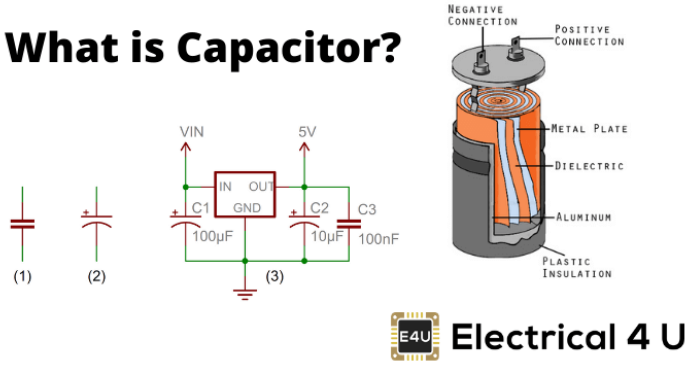
(v)Resistors used in LEDs and Transistors

Too much current passed inside a LED or transistors can be dangerous because they are very sensitive to electric current. The use of a resistor in the circuit will help the LEDs and transistors and other types of semiconductors to function in the desired current range ideal for them.

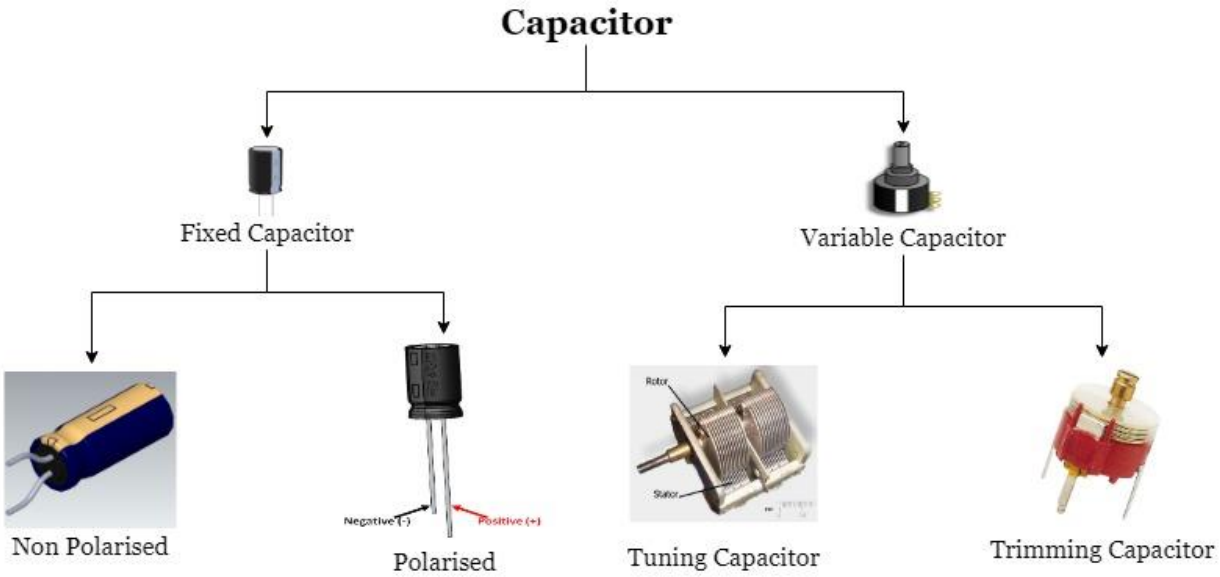
2.]Capacitors

Q. What is a Capacitor?

A capacitor is a device that stores electrical energy in an electric field by virtue of accumulating electric charges on two close surfaces insulated from each other. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass.



Q. What are the types of Capacitors?



There are two major types of Capacitors:-

1. Fixed Capacitors
2. Variable Capacitors

1.Fixed Capacitors:-

Fixed capacitors are among the major types of capacitors. These ones have fixed capacitance values.

2.Variable Capacitors:-

These ones, on the contrary, have adjustable capacitance values (these values are tunable.)

1] Fixed Capacitors

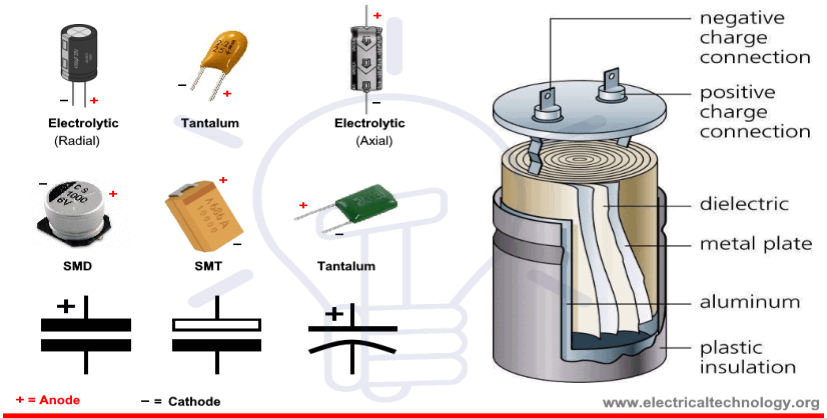
The types of Fixed Capacitors are:-

1. Polar Capacitor
2. Variable Capacitor

.1) Polar Capacitors:

Polar capacitors or **polarized capacitors** are capacitors whose terminals (electrodes) have polarity; positive and negative.

The positive terminal should be connected to positive of supply and negative to negative. Reversing the polarity will destroy the capacitor. These type of capacitors are only used in **DC** applications.



Polar capacitors are further classified into two types:

1. Electrolytic Capacitors
2. Supercapacitors

(i)Electrolytic Capacitors:

An electrolytic capacitor is a type of polar capacitor that uses an electrolyte as one of its electrodes to maintain heavy charge storage. It is made up of two metal plates whose positive (anode) plate is covered with an insulating oxide layer through **anodization**. This insulating layer acts as the dielectric. The electrolyte is used as the second terminal cathode. The electrolytes can be solid, liquid or gas type material.

Such Types of capacitors have a high capacitance value ranging from **1 µF** to **47000 µF**. They are only used in **DC** circuits.

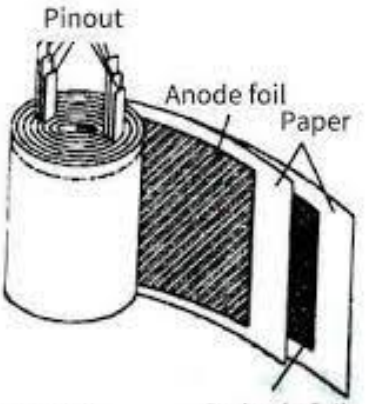
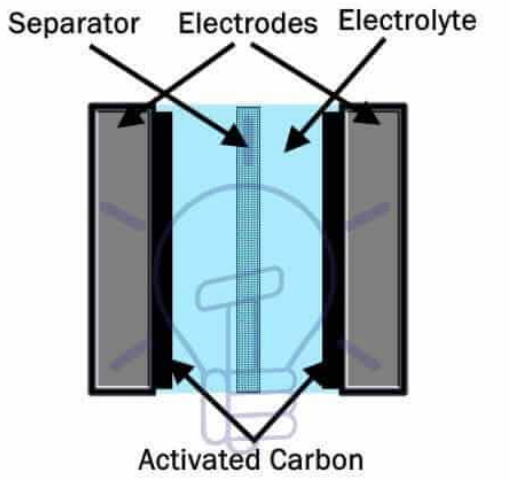


Figure 5.3

(ii)Supercapacitor

A supercapacitor is also known as ultra-capacitor or Super cap**.** A supercapacitor is a type of polar capacitor that has very high capacitance but low voltage ratings.

These types of capacitors can deliver charge much faster than a battery and store charge more than an electrolytic capacitor per volume unit. That is why it is considered between a battery and an electrolytic capacitor**.**



SuperCapacitor Construction

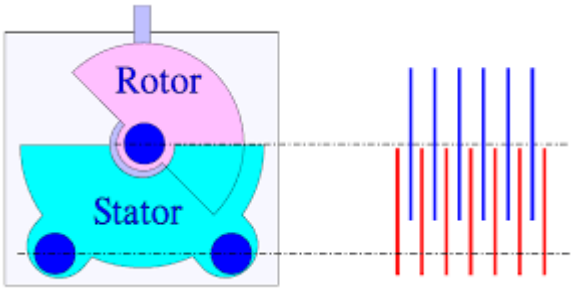
2) Non-Polar capacitors:

Non-polar or **non-polarized** capacitors are such types of capacitors whose terminals have no fixed polarity. They can be used either way in a circuit. Due to its non-polarized terminals, they are used in **DC** circuits as well as **AC** circuits.

They are cheaper than Polar capacitor but they have low capacitance and high range of voltage ratings from a few volts to thousands of volts.

2] Variable Capacitors

A Variable Capacitor is a type of capacitors whose capacitance can be changed either mechanically or electrically is known as the **variable capacitors**. They don't have fixed capacitance value instead they provide a range of values. They are used in **tuning LC circuits** for a radio receiver, **impedance matching** in antennas.



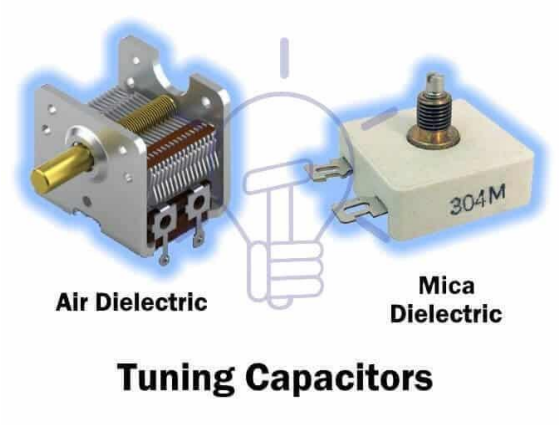
There are two sub categories of variable capacitors:-

1. Tuning Capacitors
2. Trimmer Capacitors

(i)Tuning Capacitors

This type of variable capacitor is used for tuning & is commonly used in LC circuits for radio tuning. Its capacitance can be varied by rotating a **knob** which rotates the **rotor** across the **stator** with a dielectric between them. The dielectric used is either **air** or **mica**.

They are a more robust type of variable capacitor. It is used in such circuits where the capacitance needs to be changed **more than once** in order to achieve the desired output.



(ii) Trimmer Capacitors

This type of variable capacitor's capacitance is varied by using a screwdriver. They are not very tolerant to continuous changing in capacitance. They can only withstand a few adjustments.

It has the same construction design as a tuning capacitor. The dielectric used in the trimmer capacitor is either **air** or **ceramic**.

They are used in such circuits where the capacitance does not need to be changed more than a few times. They are used in calibration circuits of equipment. Their small size allows it to be used on **PCB** (Printed Circuit Board).

Trimmer Capacitors

Q. What are the applications of Capacitors?

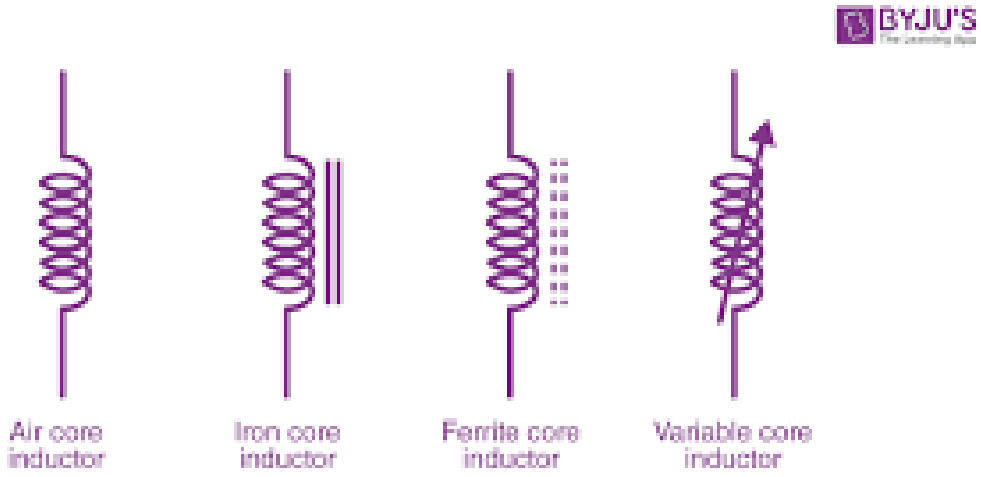
There are some of the general application for all types of capacitors.

1. Smoothing power supply's output.
2. Power factor correction
3. Frequency filters, high pass, lowpass filters.
4. Coupling & Decoupling of signals.
5. Motor Starter.
6. Snubber (Surge absorber & Noise filter)
7. Oscillators

Q. What is an Inductor?

An inductor is a passive electrical component that opposes sudden changes in current. Inductors are also known as coils or chokes. The electrical symbol for an inductor is L. Inductors slow down current surges or spikes by temporarily storing energy in an electro-magnetic field and then releasing it back into the circuit.

Q. What are the types of Inductors?



The 4 different types of Inductors are:-

1. Iron Core Inductor.
2. Air Core Inductor.
3. Iron Powder Inductor.
4. Ferrite Core Inductor

(i)Iron Core Inductor

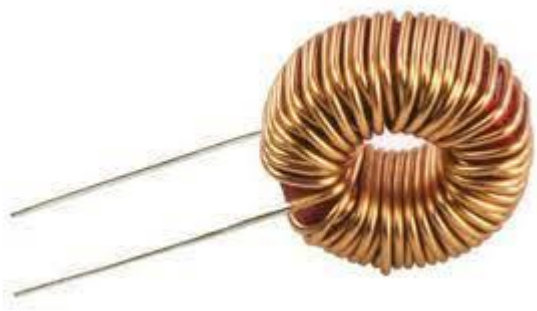
As the name suggests the core of this type of inductor is made of iron. These inductors are low space inductors that have high power and high inductance value. However, they are limited in high-frequency capacity. These inductors are used in audio equipment.

(ii)Air Core Inductor

These inductors are used when the amount of inductance required is low. Since there is no core, it does not have a core loss. But the number of turns the inductor must have is more for this type when compared to the inductors with the core. This results in a high-Quality factor. Usually, ceramic inductors are often referred to as air-core inductors.

(iii)Iron Powder Inductor

In this type of inductor, the core is Iron Oxide. They are formed by very fine and insulating particles of pure iron powder. High magnetic flux can be stored in it due to the air gap. The permeability of the core of this type of inductor is very less. They are usually below 100. They are mainly used in switching power supplies.



(iv)Ferrite Core Inductor

In this type of Inductor, ferrite materials are used as core. The general composition of ferrites is XFe_2O_4. Where X represents transition material. Ferrites can be classified into two types. Soft ferrites and hard ferrites.

- Soft Ferrite: Materials that have the ability to reverse their polarity without any external energy.
- Hard Ferrite: These are permanent magnets. That is their polarity will not change even when the magnetic field is removed.

Q. What are the applications of Inductors?

(i)Filters

Inductors are used extensively with capacitors and resistors to create filters for analog circuits and in signal processing. Alone, an inductor functions as a low-pass filter, since the impedance of an inductor increases as the frequency of a signal increases.

By combining capacitors, inductors, and resistors, advanced filter topologies support a variety of applications. Filters are used in most electronics, although capacitors are often used rather than inductors when possible since they are smaller and cheaper.

(ii) Sensors

Contact-less sensors are prized for their reliability and ease of operation. Inductors sense magnetic fields or the presence of magnetically permeable material from a distance.

Inductive sensors are central to nearly every intersection with a traffic light that detects the amount of traffic and adjusts the signal accordingly. These sensors work exceptionally well for cars and trucks. Some motorcycles and other vehicles don't offer enough of a signature to be detected by the sensors without a boost by adding an h3 magnet to the bottom of the vehicle.

Inductive sensors are limited in two major ways. Either the object to be sensed must be magnetic and induce a current in the sensor, or the sensor must be powered to detect the presence of materials that interact with a magnetic field. These parameters limit the applications of inductive sensors and influence the designs that use them.

(iii) Motors

Inductors are normally in a fixed position and aren't allowed to move to align with any nearby magnetic field. Inductive motors leverage the magnetic force applied to inductors to turn electrical energy into mechanical energy.

Inductive motors are designed so that a rotating magnetic field is created in time with an AC input. Since the speed of rotation is controlled by the input frequency, induction motors are often used in fixed-speed applications that can be powered directly from 50/60hz mains power. The biggest advantage of inductive motors over other designs is that no electrical contact is required between the rotor and the motor, making inductive motors robust and reliable.

Q. What is a Diode?

A **diode** is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction.

Diodes are also known as **rectifiers** because they change alternating current (ac) into pulsating direct current (dc). Diodes are rated according to their type, voltage, and current capacity.

Q. What is the construction of a Diode?

There are two types of semiconductor material; Intrinsic and Extrinsic semiconductor. An intrinsic semiconductor is a pure semiconductor in which hole and electrons are available in equal numbers at room temperature. In an extrinsic semiconductor, impurities are added to increase the number of holes or the number of electrons. These impurities are tri-valent (boron, indium, aluminum) or pentavalent (phosphorous, Arsenic, Antimony).

A semiconductor diode has two layers. One layer is made of a P-type semiconductor layer and the second layer is made of an N-type semiconductor layer.

If we add trivalent impurities in silicon or germanium, a greater number of holes are present and it is a positive charge. Hence, this layer is known as the P-type layer.

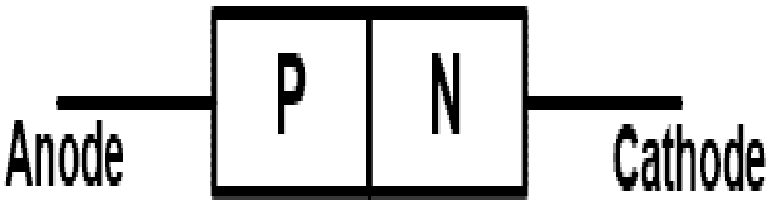
If we add pentavalent impurities in silicon or germanium, a greater number of electrons are present and it is a negative change. Hence, this layer is known as the N-type layer.

The diode is formed by joining both N-type and P-type semiconductors together. This device is a combination of P-type and N-type semiconductor material hence it is **also known as PN Junction Diode**.

A junction is formed between the P-type and N-type layers. This junction is known as PN junction.

A diode has two terminals; one terminal is taken from the P-type layer and it is known as Anode. The second terminal is taken from the N-type material and it is known as Cathode.

The below figure shows the basic construction of the diode.



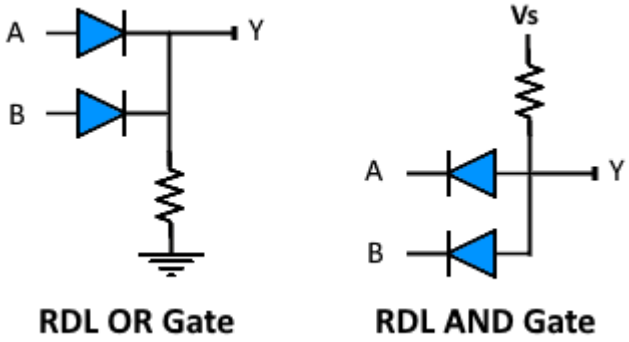
Q. What are the applications of Diodes?

Following are some of the diode's application used our daily life:

- Rectification
- As a Switch
- AM Envelope Detector or Demodulator (Diode Detector)
- As Voltage Reference

1) As a Switch (in Logic Gates)

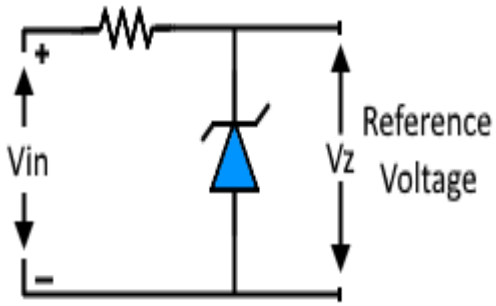
The diode acts as a switch that turns on in forward bias & turns off in reverse bias. It is used in RDL (resistor diode logic) logic. Although this design is not used in modern circuits but you can easily design the basic logic gates using diode & resistors.



RDL OR Gate **RDL AND Gate**

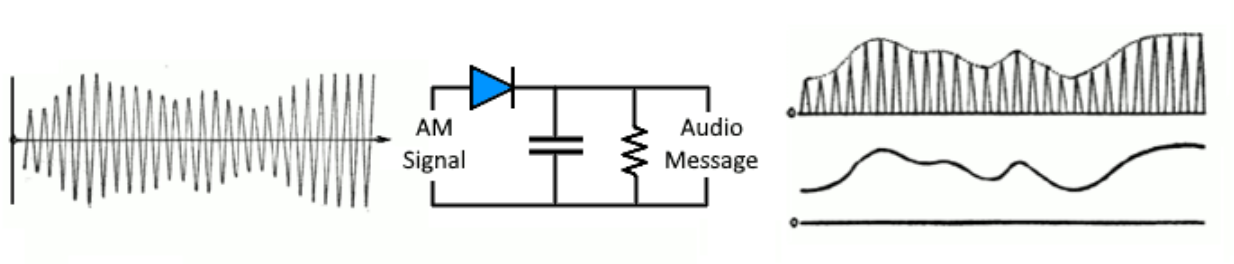
2) As Voltage Reference

The Zener diode is used as a voltage reference in various electronics circuit to provide a stable voltage for biasing. It operates as a voltage regulator in reverse bias & provides a stable voltage over a wide range of current.



3) AM Envelope Detector or Demodulator (Diode Detector)

A Diode with a capacitor is the simplest & cheapest circuit used for the demodulation of the AM signal. The audio message signal is stored in the envelope of the AM modulated signal which is detected by the diode because it only allows the positive half cycle of the signal.

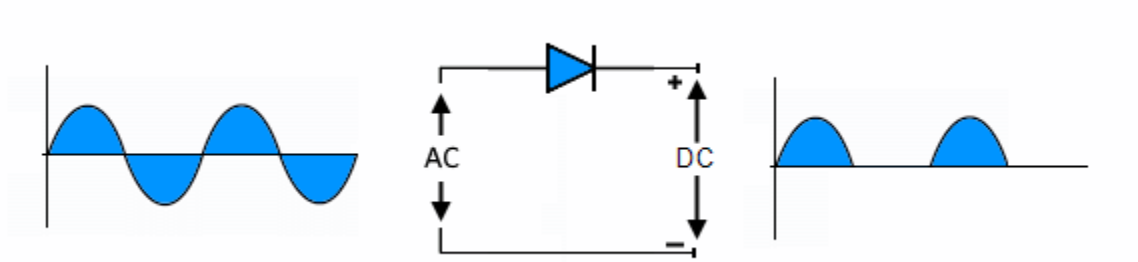


4) Rectification

The diodes were first used for the rectification purposes to convert the AC signal into a unidirectional DC signal (pure audio signal) in radios or in power supplies etc. The diodes are used in mainly two types of rectifications;

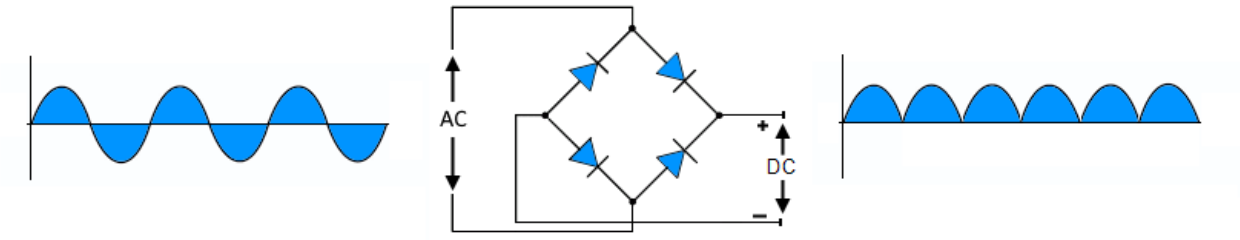
(i)Half Wave Rectification

The conversion of only half-wave of the AC signal into DC signal is called half-wave rectification. Such type of rectification is achieved by using only one diode but at the cost of losing half of signal.



(ii)Full Wave Rectification

The full-wave rectifier converts the full wave of the AC signal into DC signal. it is made up four diodes in a specific configuration known as a bridge rectifier.



It can convert the full wave of the AC signal into DC signal.