ANGELINE.S.MOSES
ASSOCIATE PROFESSOR
DEPARTMENT OF PHYSICS
I.T COLLEGE

INDEX

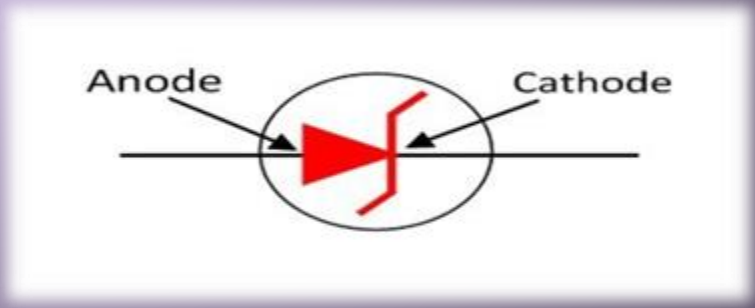
ZENER DIODE

When an ordinary crystal diode is heavily doped so that is has a sharp breakdown voltage ,it is called a zener diode ,i.e., A properly doped crystal diode which has a sharp breakdown voltage is known as a zener diode. It's a heavily doped semiconductor diode which is designed to operate in reverse direction ,it is specially designed for optimising the breakdown region .The basic function of Zener diode is to maintain a specific voltage across its terminals within given limits of line or load change.

A zener diode is a particular type of diode that allows current to flow not only from its anode to its cathode ,but also in the reverse direction ,when the so called "zener voltage" is reached. In the forward bias direction ,it behaves like an ordinary silicon diode.

Clarence Melvin Zener the American physicist invented zener diode.

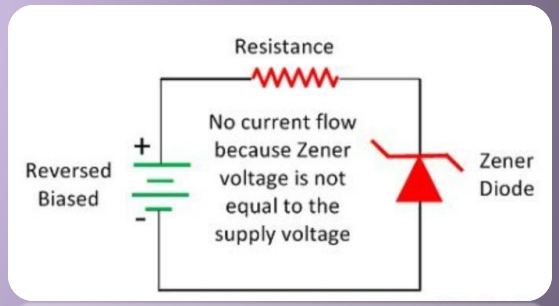
Schematic symbol of Zener Diode -



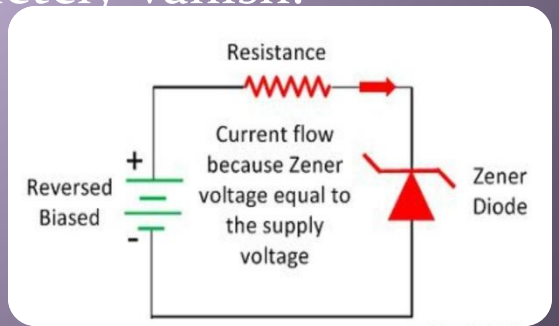
WORKING OF A ZENER DIODE

- The zener diode is made up of heavily doped semiconductor material .The heavily doped means the high level impurities is added to the material for making it more conductive due to which depletion region of the zener diode is very thin. The heavily doping material increases the intensity of electric field across the depletion region of the zener diode even for small reverse voltage.

- When no biasing is applied across the zener diode, the electrons remains in the valence band of p -type material and no current flow through the diode. The band in which the valence electrons place is known as the valence band electrons. These valence band electrons easily move from one band to another when external energy is applied across it.



- When the reverse bias applies across the diode and the supply voltage is equal to the zener voltage then it starts conducting in the reverse bias direction. The Zener Voltage is the voltage at which the depletion region completely vanish.

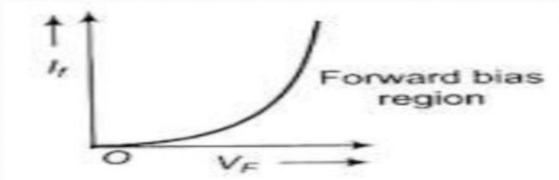


- The reverse bias applies across the diode increases the intensity of electric field across the depletion region. Thus ,it allows the electrons to move from the valence band of P-type to the conduction band of N-type material .This transferring of valence e^-_s to the conduction band reduces the barrier between the p-type and n-type material. When the depletion region become completely vanish the diode starts conducting in the reverse biased.

CHARACTERISTICS OF A ZENER DIODE

- The figure shows the ,forward characteristics is same as that of ordinary forward biased junction diode.

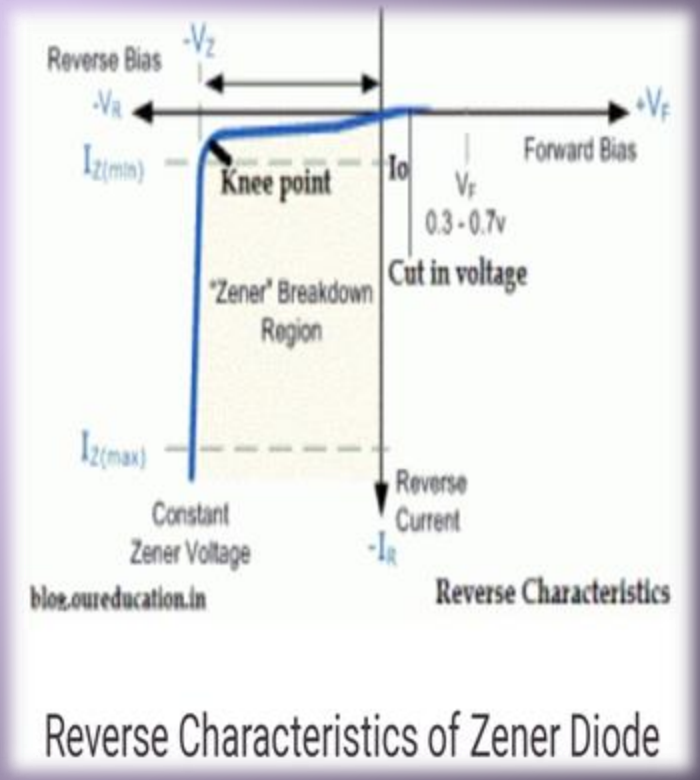
  When a forward voltage is applied, current flows through it. But due to higher doping concentration ,higher current flows through the Zener diode.



- However ,when reverse biased voltage is applied to the zener diode ,it works in different manner .When reverse biased voltage is applied to a zener diode ,it allows only a small amount of leakage current until the voltage is less than zener voltage. When reverse biased voltage applied to the zener diode reaches zener voltage, it starts allowing large amount of electric current. At this point, a small increase in reverse voltage will rapidly increases the electric current .Because of this sudden rise in electric current , breakdown occurs called zener breakdown.

The zener breakdown voltage of the zener diode depends on the amount of doping applied .If the diode is heavily doped, the zener breakdown occurs at low reverse voltages. Zener diodes are available with zener voltages in the range of 1.8V to 400V.

- Its power dissipation capacity is very high, high accuracy, small in size & low cost and are used in (voltage stabilizers, switching operations In clipping & clapping circuits,& in protection circuit).



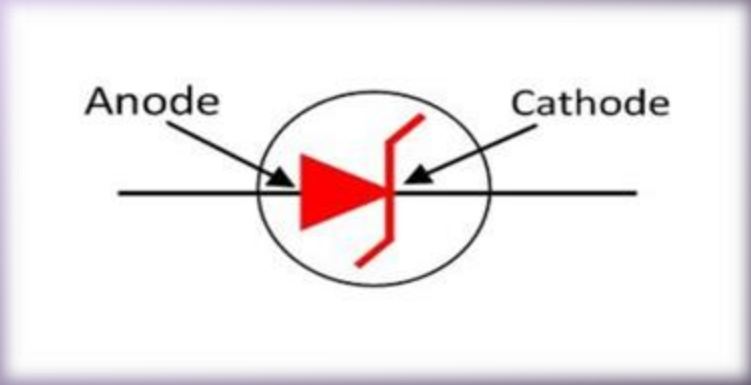
Reverse Characteristics of Zener Diode

AVALANCHE DIODE

An avalanche diode is a special type of semiconductor device designed to operate in the reverse breakdown region .Avalanches diodes are lightly doped .Therefore, the width of depletion layer in this diode is small as compared to the zener diode. Because of this wide depletion region, reverse breakdown occurs at high voltage.

Avalanche diodes are made from silicon or other semiconductor material the construction of avalanche diode is similar to zener diode .Avalanche diode consists of two terminals :anode & cathode. Its symbol is similar to the normal diode but with the bend edges on the vertical bar.

An avalanche diode allows electric current in both forward and reverse directions. However, avalanche diode is specifically designed to operate in reverse biased condition.

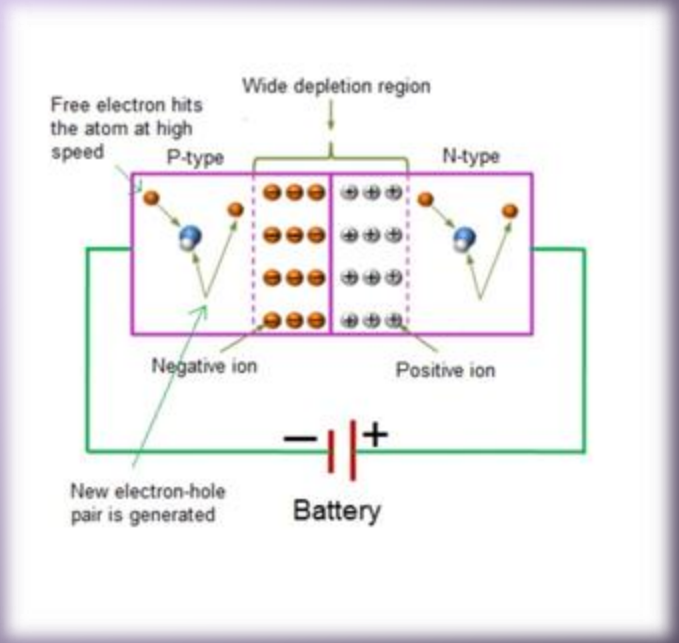


WORKING OF AN AVALANCHE DIODE

When forward bias voltage is applied to this diode ,it works like a normal p-n junction diode by allowing electric current through it .

When reverse bias voltage is applied to this diode ,the free e^-_s (majority carriers) in the n-type semiconductor & the holes (majority carriers) in the p-type semi-conductor are moved away from the junction. As a result, the width of deplet-ion region increases. So, the majority carriers will not carry electric current. However, the minority carriers experience a repulsive force from external voltage. As a result, the minority carriers flow from p to n type and n to p type by carrying the electric current. But current carried by minority carriers is very small. And this current is called reverse leakage current.

If the reverse bias voltage is further increased, the minority carriers will gain large amount of energy & Accelerated to greater velocities. The free e^-_s moving at high speed will collide with the atoms & transfer their energy to the valence electrons.



The valence e^-_s which gains enough energy from the high-speed e^-_s will be detached from the parent atom and become free e^-_s . These free e^-_s are again accelerated .When these free e^-_s again collide with each other atoms, they knock off more e^-_s

Because of this continuous collision with the atoms, a large number of minority carriers (free electrons or holes) are generated. These large numbers of free electrons carry excess current in the diode.

When the reverse voltage applied to the avalanche diode continuously increases at some point junction breakdown or Avalanche Breakdown occurs. At this point, a small increase in voltage will suddenly increase the electric current

The V-I characteristics are the variation of current for the applied voltage. The figure shows the characteristics of Avalanche breakdown(Avalanche diode).It occurs when a diode is in reverse bias condition. It occurs at a breakdown voltage of more than 6V.

This diode is used for the protection of the circuit against unwanted voltages & are used in surge protectors to protect the circuit from surge voltage.

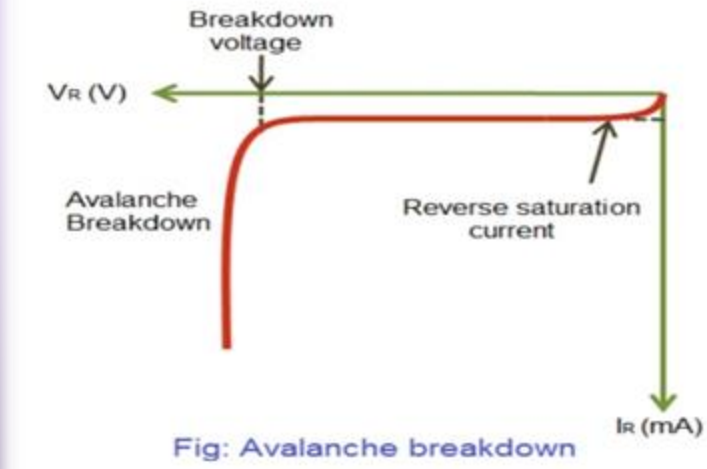


Fig: Avalanche breakdown

THERMISTOR

A Thermistor is a type of resistor used to measure the temperature changes, relying on the change in its resistance with changing temperature. Thermistor is a combination of the words thermal and resistor .The thermistor was invented by Samuel Ruben in 1930.

A thermistor is mostly made from sensitive semiconductor based metal oxides with metallised or sintered connecting leads onto a ceramic disc or bead.

" A two terminal solid state thermally sensitive transducer ,that allows a significant change in its resistive value with respect to change in ambient temperature."

Thermistors act as a passive component in a circuit. They are an accurate ,cheap, and robust way to measure temperature. They are ideal when a precise temperat--ure reading is required. They are available in various shapes like disc, rod, washer, etc.

Symbol of Thermistor is shown-

WORKING OF A THERMISTOR

The Thermistor works on a simple principle : Change in temperature of the Thermistor ,leads to change in its resistance. The Thermistor's temperature can change either due to external factors or due to internal factors. The most import--ant internal factor is the current flowing through the device . As the current through it increases , it starts self heating its elements .This causes a rise in temp--erature of the Thermistor. We can measure its temperature using an ohmmeter.

TYPES OF THERMISTOR

There are two types of Thermistors :

- Negative Temperature coefficients(NTC) Thermistor
- Positive Temperature Coefficients (PTC) Thermistor

NTC Thermistor- This type of thermistor has the property where the resistance decreases with increase in temperature and resistance increases with decrease in temperature.

PTC Thermistor- This type has the property where the resistance increases with increasing temperature.

USES OF THERMISTORS:

- In Digital thermometers(thermostats)
- Automotive applications (to measure oil coolant temperatures in cars & trucks).
- Household appliances(like microwaves, fridges, and ovens).
- Circuit protection(i.e. surge protection).
- To measure the thermal conductivity of electrical materials.
- Useful in many basic electronic circuits (e.g. as part of a beginner Arduino star-

-ter kit).

ADVANTAGES OF THERMISTORS:

- Thermistors have high sensitivity ,better than offered by thermocouples, RTD's.
- High accuracy , ~±0.02˚c(±0.36 ˚F)
- They offer a wide range of high resistance values.
- They have a small size.
- Thermistors have a faster response time than that of RTD's.