

# Diodes and Their Application

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**Abstract**— Diode, an electronic component with two terminals and routes the current in single direction. Any ideal diode have '0' voltage to current ratio in single direction and ' $\infty$ ' voltage to current ratio in opposite direction. And as the diode have a tendency to conduct the current in single direction, it is assumed to have "asymmetrical conductance". Present day, almost all the diodes are silicon based and a few others are made from germanium. Following are types of diodes with their applications, advantages and disadvantages.

**Keywords**— Diode, Rectification, Semiconductor.

**Introduction:** Remarkably, common job of a diode, is that it allows electric current to flow only in single direction i.e in its forward track, whereas cutting off/preventing its flow in reverse direction. This tendency to conduct in a one direction is termed as "rectification". This rectification is utilized to change a.c to d.c. Diode possess nonlinear current – voltage characteristics but have a lot of applications.

The earliest were Vacuum tube diodes and solid i.e semiconductor diodes; invented independently but about same time, in 1900s. The word diode was made from Greek syllable "di" mean –two and "ode" mean –path, by William Henry Eccles.

## 1. PN Junction Diode

It's a Facile Semiconductor Device. It has two regions namely P-type, N-type. Depending upon voltage application, it has three conditions of 'biasing'. Forward bias, also termed as providing 'positive voltage.' The diode is known to be Zero Bias "when no voltage applied externally" and Reverse Bias "when '-ve' voltage connected to P-type and '+ve' to N-type and "Forward Bias" when '+ve' is to P-type and '-ve' to N-type.

**Applications**

- Utilized for the conversion of A.C. to D.C.
- Also as clipper, as a clamper and as Wave shaping circuits in computers, radars.
- As a switch and In a demodulator circuitry.

**Advantages**

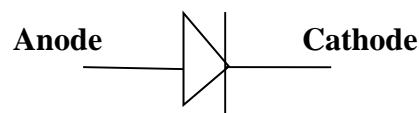
- Good lifetime

- Compact

**Disadvantages**

- It fails to work in reverse biased state

**Symbol**



## 2. Backward Diode

This diode works in reverse biased mode, so known as Backward Diode. In its symbol, anode seems similar to ideal diode but cathode is modified a little. However, its operation is same as that of tunnel diode. The technique of 'Quantum tunneling' is significant. Its symbol depicts variation on Zener or Tunnel diode. It posses improved conduction for limited reverse biases (-0.1 to -0.6V). This diode is also termed as back diode. The operation of Backward diode in reverse biasing is same as any diode working in forward biasing. Constructed same as tunnel diode and also the characteristics appear as similar a tunnel diode.

**Applications**

- Switch
- Rectifier

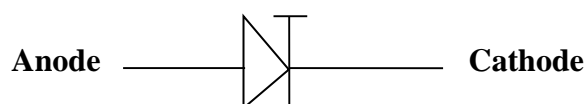
**Advantages**

- Backward diode is less temperature sensitive than other diode.

**Disadvantages**

- It can't tolerate extremely high reverse voltages.
- It has high degree Noise

**Symbol**



### 3. IMPATT Diode

It is Impact Ionization Avalanche Transit Time Diode. Its architecture is identical to that of 'Schottky' or 'PIN' diode and V-I characteristics identical to 'P-N junction' diode. It starts conducting in onward way as soon as it reaches 'turn on' voltage. While in opposite i.e reverse direction, it hinders the flow of current till it reaches breakdown voltage. Utilized in generation of RF Signals and it has good power capacity. But IMPATT diode isn't much used presently. Structure resembles a standard P-N junction and needs high operating voltage. Its operating frequency 3-100GHz.

#### Applications

- In modulated output oscillator
- Microwave generator
- Transmission of FM in telecom

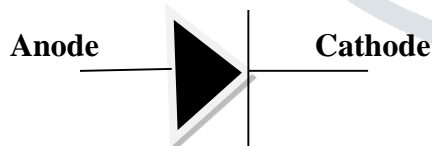
#### Advantages

- Good power capacity ,output is better and accurate
- Good at generation of micro wave signals

#### Disadvantage

- Less efficient than "TRAPATT" Diode
- Tuning range inferior to Gunn Diode
- Noisy compared to Klystrons and Gunn Diode

#### Symbol



### 4. GUNN Diode

This is also termed as TED (Transferred Electron Device) and is Passive device .Its Conventional fabrication process comprises flourishing of epitaxial layer on substrate for the formation of 3 N-type semiconductor layers. In 3 layered regions, intermediate is thin and lightly doped and other 2 are heavily.

#### Applications

- Radars used by Police and Military applications
- Parametric amplifiers and Microwave receiver circuit

- Traffic signal controllers

#### Advantages

- Stable at high frequencies with broader bandwidth
- Compact and Economical

#### Disadvantages

- Unstable as the temperature rises
- Inefficient below 10GHz

#### Symbol



### 5. LASER DIODE

LASER diode is also called as injection laser diode. Its twin to LED. Laser diode works on the principle of 'Quantum theory'. According to this, atoms when at ground level can be excited to move to higher level. Being there for small while, it returns to ground state with the emission of Photon. These photons then become source of light. So it can be concluded that it can change electrical energy to light energy .

#### Applications

- Bar Code readers
- Laser Pointers, Laser Printing and Laser Scanning
- Fiber optic communication

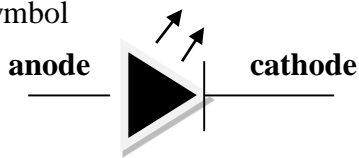
#### Advantages

- Possess very good efficiency and is cost effective
- Effortlessly fabricated in arras and delivers large power O/P
- Requires less power for operation

#### Disadvantages

- Costlier for bigger source
- Serious heating issue

Symbol



## 6. Light Emitting Diode

Electrons and holes recombine and gives out energy as 'photons'. Thus gives out light energy when in active mode. As soon as required voltage is given,  $e^-$  go and meet the hole, recombination of both takes place delivering out light. Emit light as soon as current progresses through it and possess the phenomenon Electroluminescence

Applications

- Optical displays
- Illumination
- Optical communication

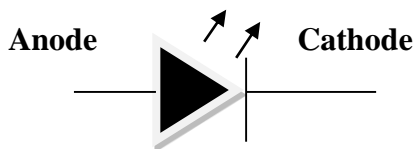
Advantages

- Cost efficient, Brighter, Robust and lower power requirement with no Maintenance
- Good Life time and Power Efficient
- Available in different colors and Environment friendly

Disadvantages

- Dependant on ambient temperature and requires "Thermal Management"
- Sensitive to variations in Voltages and have very small illumination range

Symbol:



## 7. Photo Diode

This is also termed as 'Photo detector', 'Light detector' or sometimes 'Photo sensor'. They are made such that, they are operated in reverse bias, i.e. when p-type given to '+ve' of battery and n-type to '-ve' of the battery. As soon as light falls on it, gets light energy converted in electric current. The act is slower in time when its surface area is expanded. Its opposite to the working of LED. Conclusively, changes light energy to electrical.

Applications

- Smoke detectors
- Remotes of TV, AC

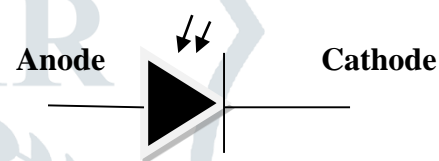
Advantages

- Linear, Fast, Compact and Good Lifetime
- Good Frequency response with Less Noise
- Mechanically Strong and Works on even low Voltages

Disadvantages

- Sensitive to light
- Unstable when "Changes in Temperature" and have got very small illumination range
- Active area is very low and requires offset voltage

Symbol



## 8. PIN Diode

The PIN Diode operates as a "variable resistance" in case of forward bias operation. P-type and N-type regions are heavily doped and has good intrinsic region unlike P-N junction diode. Immense electric field is grown over the junction which boosts up the movement of charge carriers and benefits in accelerated action and so utilized in high frequency operations. Operation takes place in high level injection.

Applications

- As a photo detector in fiber optics
- As a variable register for radio and micro wave frequency

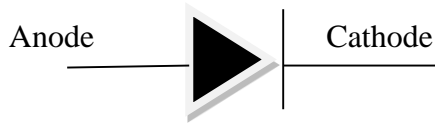
Advantages

- Linear with a good Frequency response
- Great Speed but Less Noisy
- Tolerance of high reverse voltage

Disadvantage

- Internal gain is almost '0'
- Time response is at its lower side

Symbol:



## 9. Schottky Diode

It is not just a semiconductor diode unlike all the other diodes but a Metal-semiconductor diode. Also known as “Schottky Barrier Diode” or “hot carrier Diode”. Possess fast Switching speed and works better in “Sample and Hold Circuit” than P-N Junction diode. The utmost significant factor is its rapid switching rate and minimum forward voltage drop. The junction thus formed by metal-semiconductor do not possess the ability to accumulate charges at the junction since there does not exist any depletion region.

Applications

- Rectifiers
- In logic circuits and ‘RADAR’ system
- Fast Switching device in digital computers

Advantages

- Have good “Current Density” with low Switching time and less power consumption.
- Low “Cutting Voltage” i.e zero

Disadvantages

- Thermally unstable
- Have high “Reverse Leakage Current”
- Expensive

Symbol:

