TESCA™

Tesca Technologies Pvt. Ltd.

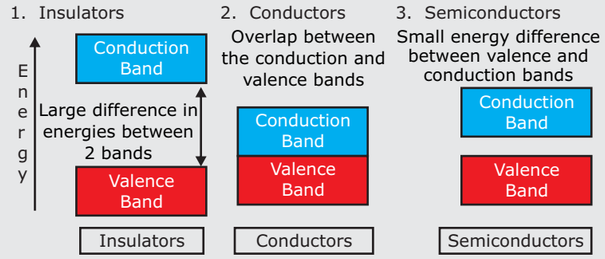
Diode

Semiconductor

Energy Band Diagram

The energies that an electron possess in an atom is known as the energy band. Energy bands are Valence Band, Conduction Band & Forbidden Band.

Classification of Solids according to Energy Bands

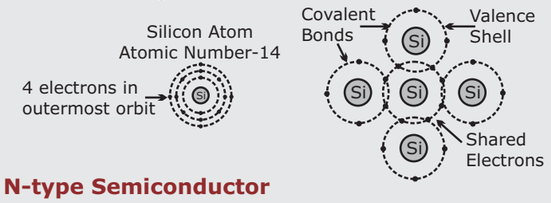


The large energy gap between the valence and conduction bands in an insulator says that at ordinary temperatures, no electrons can reach the conduction band.

In semiconductors, the band gap is small enough that thermal energy can bridge the gap for a small function of the electrons. In conductors, there is no band gap since the valence band overlaps the conduction band.

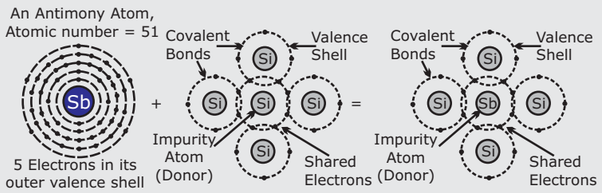
Semiconductor Basics

Semiconductor materials : Silicon (Si), Germanium (Ge) and Gallium Arsenide (GaAs), have electrical properties somewhere in the middle of a "conductor" and an "insulator". The are not good conductors nor good insulators (hence there name is "semi" conductor). However, their ability to conduct electricity can be greatly improved by adding certain "impurities"



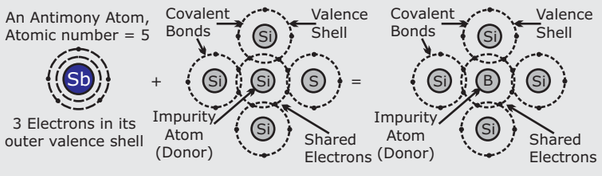
N-type Semiconductor

Pentavalent additive: Antimony (Sb), Phosphorus (P) or Arsenic (As): Pentavalent additive allows four out of the five orbital electrons to bond with its neighboring silicon atoms leaving one "free electron"



P-Type Semiconductor

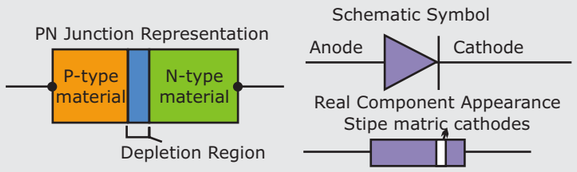
Trivalent Additive: Aluminium (Al), Boron (B) or Indium (In) Trivalent additive have only three valence electrons available in their outermost orbital, the fourth closed bond can not be formed.



PN Junction Diode

Formation of PN Junction Diode

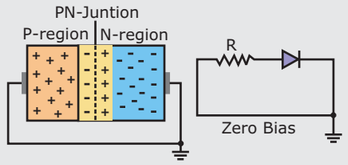
PN Junction is formed by joining P-type and N-type materials.



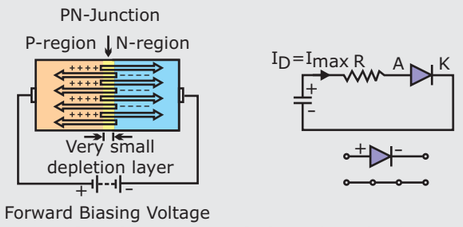
Biasing

There are two operating regions and three possible "biasing" conditions :

1. Zero Biased Junction Diode: No external voltage is applied to the PN- junction. No current flows through diode.

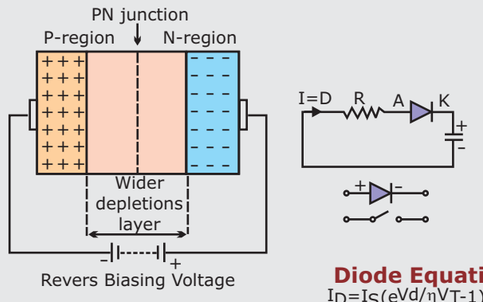


2. Forward Biased Junction Diode: When (+Ve) terminal of battery is connected to P-type and (-Ve) to N-type material Battery voltage increases-Depletion layer decreases. Resistance decreases and forward current increases.

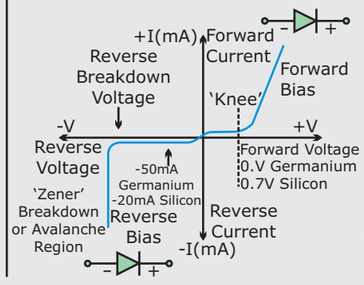


3. **Reverse Biased Junction Diode:** When (-Ve) terminal of battery is connected to P-type and (+Ve) to N-type material.

Battery voltage increases-depletion layer increases-resistance increases hence reverse saturation current flows.



V-I Characteristics



Diode Equation

$I_D = I_S(e^{Vd/\eta VT}-1)$

Where,

I_d= Diode current (Amp)

V_D= Diode Voltage (Volts)

I_i= Saturation Current (Amp)

η= Emission Coefficient (1 s η s 2) depending on the material

V_T= Thermal Voltage = $\frac{KT}{q}$ $\frac{T}{11.600}$

K= Boltzmann's Constant = 1.33×10^{24} J/K

T (kelvin) = 273 + T(°C)

q (Change of electron)= 1.6° 10°C

The equation is not valid in the reverse breakdown region

Zener Diode

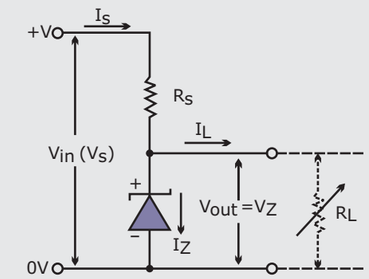
The Zener diode is like a silicon PN junction diode.

The zener diode is used in its "reverse bias" or reverse breakdown mode.

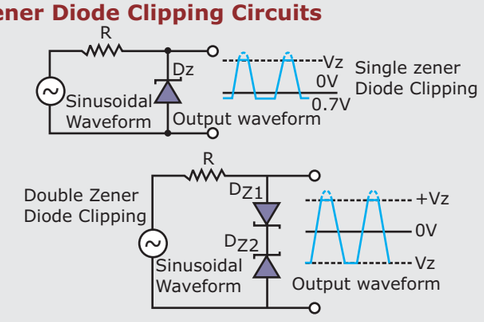
The fact that the voltage across the diode in the breakdown region ia almost constant turns out to be an important application of the Zener diode as a voltage regulator.

The function of regulator is to provide a constant output voltage to a load connected in parallel.

D.C. Input voltage from rectifier or smoothing circuit

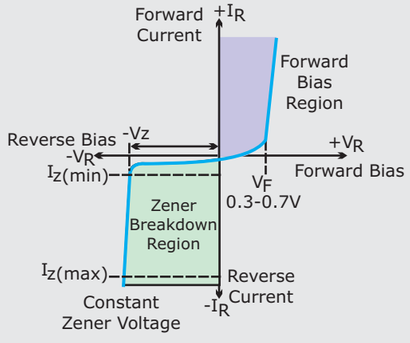


Zener Diode Clipping Circuits



Diode clipping and clamping circuits are used to shape an input AC waveform (or any sinusoid).

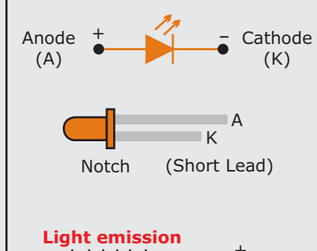
V-I Characteristics of Zener Diode

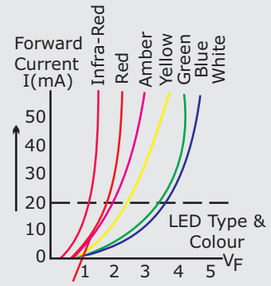


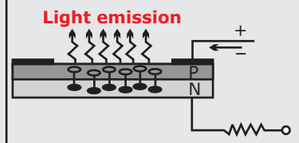
Light Emitting Diode

LED is a type of PN junction diode, made from a very thin layer of fairly heavily doped semiconductor material.

When LED is forward biased, electrons recombine with holes releasing sufficient energy to produce photons which emit a monochromatic (single colour of light. LED converts electrical energy into light energy).



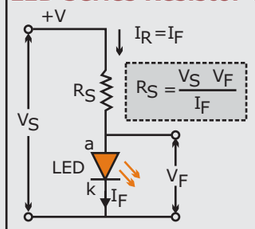




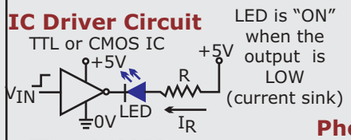
By mixing together a variety of semiconductor, metal and gas compounds the following list of LEDs can be produced:

- GaAs -infra-red
- GaAsP - red to infra-red orange
- AlGaAsP - high-brighteness red, orange-red, orange, and yellow
- GaP- red, yellow and green
- AlGap -green
- GaN- red, yellow and green
- AlGap -green
- GaInN - near ultraviolet, bluish-green and blue

LED Series Resistor Circuit



IC Driver Circuit



Typical Seven Segment LED Display

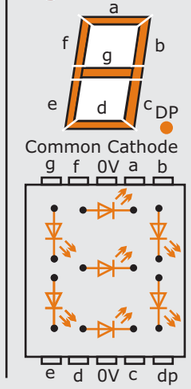
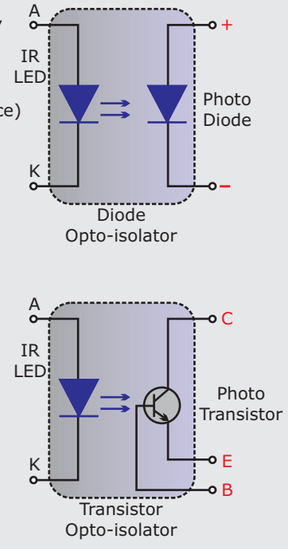
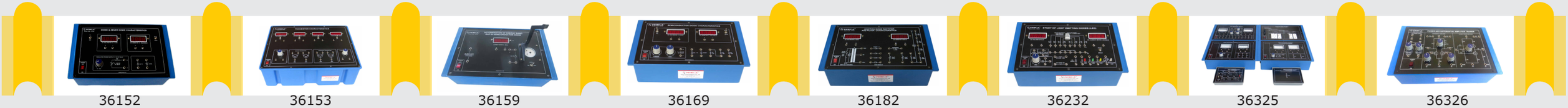


Photo Diode and Photo Transistor Opto-couplers





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