LED

The light emitting diode is the most visible type of semiconductor diode. They emit narrow bandwidth of either visible light at different coloured wavelengths, invisible infra-red light for remote controls or laser type light when a forward current is passed through them. The “Light Emitting Diode” or LED is basically just a specialised type of diode as they have very similar electrical characteristics to a PN junction diode. This means that an LED will pass current in its forward direction but block the flow of current in the reverse direction. Light emitting diodes are made from a very thin layer of fairly heavily doped semiconductor material and depending on the semiconductor material used and the amount of doping, when forward biased an LED will emit a coloured light at a particular spectral wavelength.
When the diode is forward biased, electrons from the semiconductors conduction band recombine with holes from the valence band releasing sufficient energy to produce photons which emit a monochromatic (single colour) of light. Because of this thin layer a reasonable number of these photons can leave the junction and radiate away producing a coloured light output. Light Emitting Diodes are semiconductor devices that convert electrical energy into light energy when operated in a forward biased direction .

LED’s are manufactured with two legs protruding from the bottom of the body. Light emitting diodes have their cathode, (–) terminal identified by the cathode lead being shorter than the other as the anode (+) lead is longer than the cathode (k).

Light Emitting Diodes are made from exotic semiconductor compounds such as Gallium Arsenide (GaAs), Gallium Phosphide (GaP), Gallium Arsenide Phosphide (GaAsP), Silicon Carbide (SiC) or Gallium Indium Nitride (GaInN) all mixed together at different ratios to produce a distinct wavelength of colour.

Light emitting diodes are available in a wide range of colours with the most common being red, yellow, and green and are thus widely used as visual indicators and as moving light displays.
The main P-type dopant used in the manufacture of Light Emitting Diodes is Gallium (Ga, atomic number 31) and that the main N-type dopant used is Arsenic (As, atomic number 33) giving the resulting compound of Gallium Arsenide (GaAs) crystalline structure.
The problem with using Gallium Arsenide on its own as the semiconductor compound is that it radiates large amounts of low brightness infra-red radiation (850nm-940nm approx.) from its junction when a forward current is flowing through it.

The amount of infra-red light it produces is okay for television remote controls but not very useful if we want to use the LED as an indicating light. But by adding Phosphorus (P,

atomic number 15), as a third dopant the overall wavelength of the emitted radiation is reduced to below 680nm giving visible red light to the human eye. Further refinements in the doping process of the PN junction have resulted in a range of colours spanning the spectrum of visible light as we have seen above as well as infra-red and ultra-violet wavelengths.
By mixing together a variety of semiconductor, metal and gas compounds the following list of LEDs can be produced.

Types of Light Emitting Diode

- Gallium Arsenide (GaAs) – infra-red
- Gallium Arsenide Phosphide (GaAsP) – red to infra-red, orange
- Aluminium Gallium Arsenide Phosphide (AlGaAsP) – high-brightness red, orange-red, orange, and yellow
- Gallium Phosphide (GaP) – red, yellow and green
- Aluminium Gallium Phosphide (AlGaP) – green

Most common LED's require a forward operating voltage of between approximately 1.2 to 3.6 volts with a forward current rating of about 10 to 30 mA, with 12 to 20 mA being the most common range. Both the forward operating voltage and forward current vary depending on the semiconductor material used but the point where conduction begins and light is produced is about 1.2V for a standard red LED to about 3.6V for a blue LED. LED is effectively a diode, its forward current to voltage characteristics curves can be plotted for each diode colour as shown below.

Light Emitting Diodes I-V Characteristics.

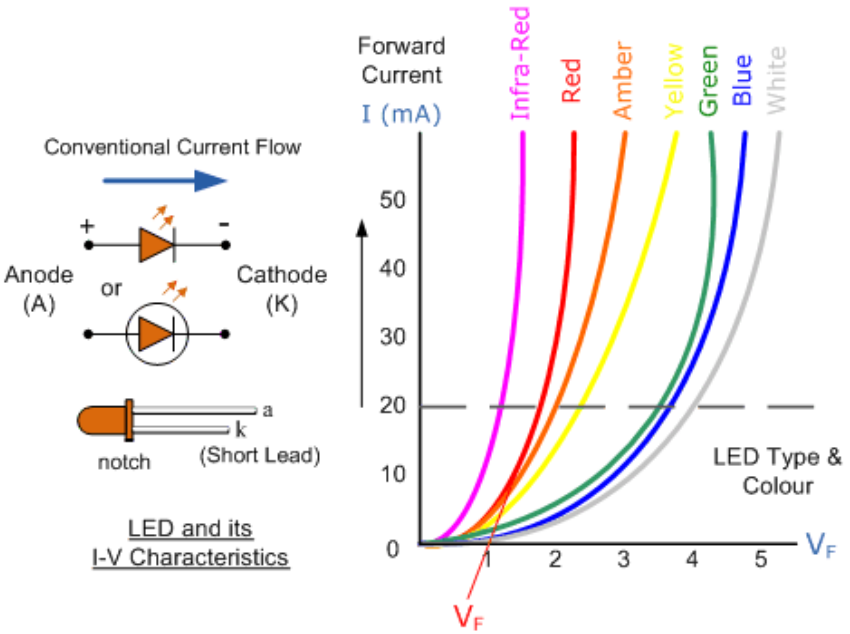

Fig: Light Emitting Diode (LED) Schematic symbol and I-V Characteristics Curves showing the different colours available

It is a current dependant device with their light output intensity being directly proportional to the forward current flowing through the LED.

As the LED is to be connected in a forward bias condition across a power supply it should be current limited using a series resistor to protect it from excessive current flow. Never connect an LED directly to a battery or power supply as it will be destroyed almost instantly because too much current will pass through and burn it out.

LEDs are operated from a low voltage DC supply, with a series resistor, RS used to limit the forward current to a safe value from say 5mA for a simple LED indicator to 30mA or more where a high brightness light output is needed.

Various applications of LED

LEDs (Light Emitting Diodes) are widely used in various applications due to their efficiency. Some key areas include: lighting, displays, automotive, and optical communication.

Lighting:

General Lighting:

LEDs are increasingly popular for residential, commercial, and industrial lighting, offering energy savings and long lifespan.

Street Lighting**:**

LED streetlights are becoming common due to their energy efficiency and reduced maintenance.

Automotive Lighting:

LEDs are used in headlights, taillights, brake lights, and turn signals in vehicles.

Displays:

TV Backlighting: LEDs are used as backlights for LCD TVs.

Smartphone Displays: LEDs are used in smartphone screens.

Digital Clocks and Calculators: LEDs are used for displaying digits.

Optical Communication:

Fibre Optic Cables: LEDs are used in fiber optic communication for transmitting data.