
ELECTRONICS DEVICES AND CIRCUITS

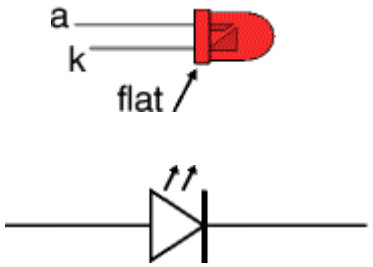
OBJECTIVE

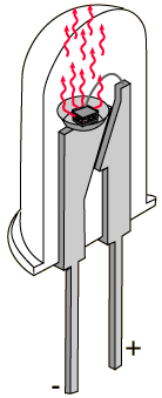
OPTICAL EXCITATION IN DIODE

LED

A light emitting diode (LED) is essentially a PN junction opto-semiconductor that emits a monochromatic (single color) light when operated in a forward biased direction.

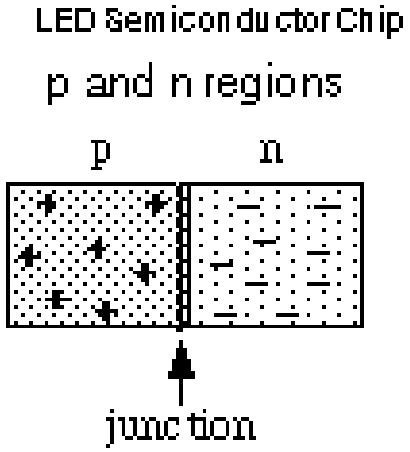
LEDs convert electrical energy into light energy. They are frequently used as "pilot" lights in electronic appliances to indicate whether the circuit is closed or not.

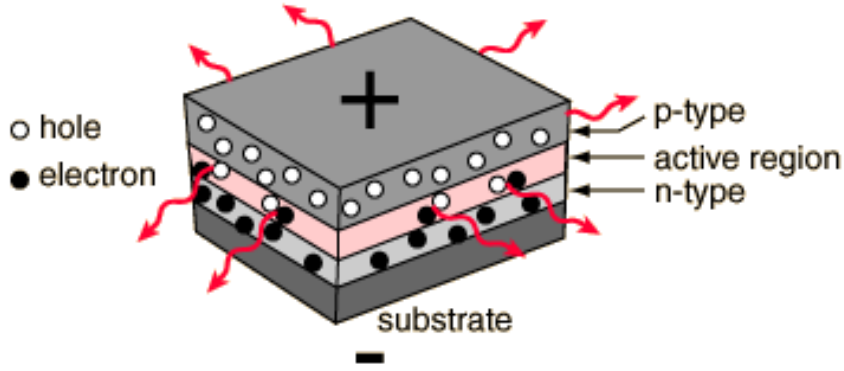




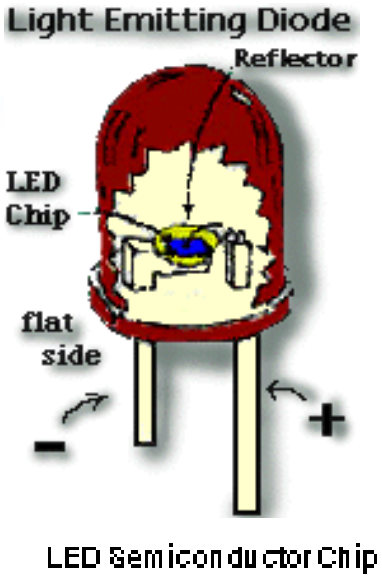
About LEDs (1/2)

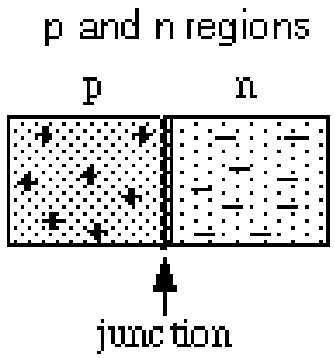
The most important part of a *light emitting diode (LED)* is the semi-conductor chip located in the center of the bulb as shown at the right. The chip has two regions separated by a *junction*. The *p region* is dominated by positive electric charges, and the *n region* is dominated by negative electric charges. The *junction* acts as a barrier to the flow of electrons between the *p* and the *n regions*. Only when sufficient voltage is applied to the semi-conductor chip, can the current flow, and the electrons cross the junction into the *p region*.





How Does A LED Work? (1/2)



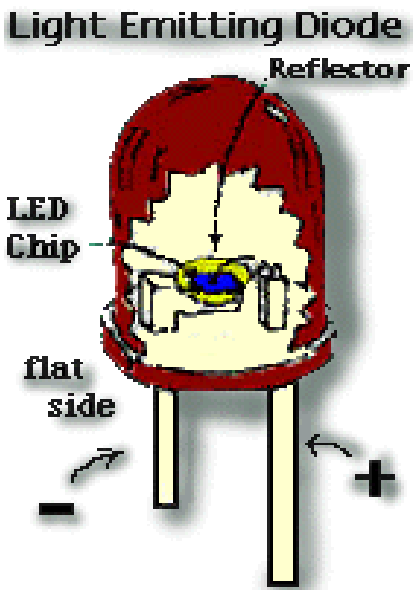


When sufficient voltage is applied to the chip across the leads of the LED, electrons can move easily in only one direction across the *junction* between the *p* and *n* regions.

In the *p region* there are many more positive than negative charges.

When a voltage is applied and the current starts to flow, electrons in the *n region* have sufficient energy to move across the junction into the *p region.*

How Does A LED Work? (2/2)



Each time an electron *recombines* with a positive charge, electric potential energy is converted into electromagnetic energy.

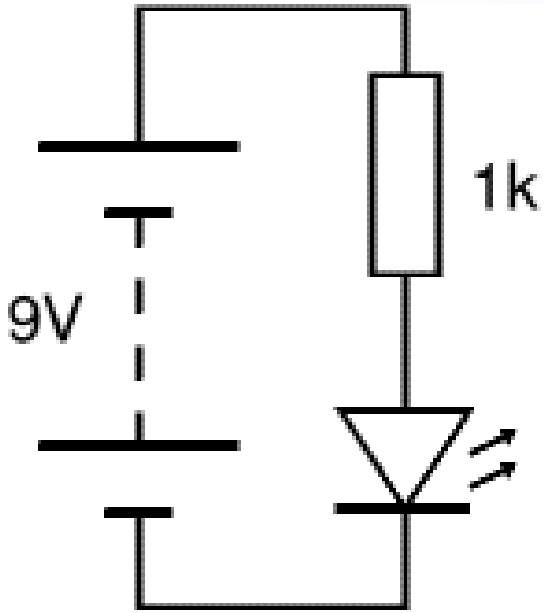
For each recombination of a negative and a positive charge, a quantum of electromagnetic energy is emitted in the form of a photon of light with a frequency characteristic of the semi-conductor material (usually a combination of the chemical elements gallium, arsenic and phosphorus)..

Testing LEDs

Never connect an LED directly to a battery or power supply! It will be destroyed almost instantly because too much current will pass through and burn it out.

LEDs must have a resistor in series to limit the current to a safe value, for quick testing purposes a 1k resistor is suitable for most LEDs if your supply voltage is 12V or less.

Remember to connect the LED the correct way round!



How Much Energy Does an LED Emit?

The energy (E) of the light emitted by an LED is related to the electric charge (q) of an electron and the voltage (V) required to light the LED by the expression: $E = qV$ Joules.

This expression simply says that the voltage is proportional to the electric energy, and is a general statement which applies to any circuit, as well as to LED's. The constant q is the electric charge of a single electron, -1.6×10^{-19} *Coulomb*.

Finding the Energy from the Voltage

Suppose you measured the voltage across the leads of an LED, and you wished to find the corresponding energy required to light the LED. Let us say that you have a red LED, and the voltage measured between the leads of is 1.71 Volts. So the Energy required to light the LED is

$E = qV$ or $E = -1.6 \times 10^{-19}$ (1.71) Joule,

since a Coulomb-Volt is a Joule. Multiplication of these numbers then gives

$E = 2.74 \times 10^{-19}$ Joule.

Applications

- Sensor Applications
- Mobile Applications
- Sign Applications
- Automative Uses
- LED Signals
- Illuminations
- Indicators

Sensor Applications

- Medical Instrumentation
- Bar Code Readers
- Color & Money Sensors
- Encoders
- Optical Switches
- Fiber Optic Communication

Mobile Applications

- Mobile Phone
- PDA's
- Digital Cameras
- Lap Tops
- General Backlighting

Sign Applications

- Full Color Video
- Monochrome Message Boards
- Traffic/VMS
- Transportation - Passenger Information

Automative Applications

- Interior Lighting - Instrument Panels & Switches, Courtesy Lighting
- Exterior Lighting - CHMSL, Rear Stop/Turn/Tail
- Truck/Bus Lighting - Retrofits, New Turn/Tail/Marker Lights

Signal Appications

- Traffic
- Rail
- Aviation
- Tower Lights
- Runway Lights
- Emergency/Police Vehicle Lighting

LEDs offer enormous benefits over traditional incandescent lamps including:

- Energy savings (up to 85% less power than incandescent)
- Reduction in maintenance costs
- Increased visibility in daylight and adverse weather conditions

Illumination (1/2)

- Architectural Lighting
- Signage (Channel Letters)
- Machine Vision
- Retail Displays
- Emergency Lighting (Exit Signs)
- Neon Replacement
- Bulb Replacements
- Flashlights
- Outdoor Accent Lighting - Pathway, Marker Lights