

## Electronic Basics #8: Everything about LEDs and current limiting resistors

### Introduction

Light Emitting Diodes (LEDs) are semiconductor devices that emit light when an electric current flows through them. Due to their energy efficiency, durability, and compact size, LEDs have become an essential component in modern electronic projects. They are used in a wide range of applications, from indicator lights in circuits to high-brightness displays and smart lighting systems.

### Basic Structure of an LED

An LED consists of multiple layers of semiconductor materials:

1. **P-type Semiconductor** – Contains holes (positive charge carriers).
2. **N-type Semiconductor** – Contains free electrons (negative charge carriers).
3. **Active Region (Junction)** – The region where electrons and holes recombine to emit light.
4. **Encapsulation (Lens)** – A transparent or colored plastic cover that protects the LED and enhances light dispersion.
5. **Anode (+) and Cathode (-) Leads** – The two terminals used for connecting the LED to a power source.

### Types of LEDs

LEDs come in various types, each designed for specific applications:

1. **Standard LEDs** – Used in electronic circuits as indicator lights.
2. **High-Brightness LEDs** – Found in flashlights, automotive lighting, and display panels.
3. **RGB LEDs** – Capable of producing different colors by combining red, green, and blue light.
4. **Infrared LEDs** – Emit infrared radiation, commonly used in remote controls and security systems.
5. **Surface-Mount LEDs (SMDs)** – Compact LEDs used in modern electronic devices like smartphones and LED strips.
6. **Organic LEDs (OLEDs)** – Used in high-resolution displays, offering high contrast and flexibility.

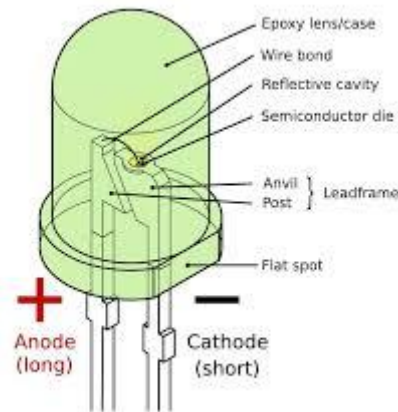


Fig8.1: LED Basic Structure

### How LEDs Work?

LEDs operate on the principle of **electroluminescence**. When voltage is applied, electrons move from the **N-type** region to the **P-type** region. As electrons recombine with holes at the junction, energy is released in the form of light. The color of the emitted light depends on the semiconductor material and its bandgap energy.

### LED Configuration (Anode and Cathode)

- **Anode (+):** The longer lead, which connects to the positive terminal of the power supply.
- **Cathode (-):** The shorter lead, which connects to the negative terminal.

For LEDs in circuits, a **current-limiting resistor** is typically used to prevent excessive current flow, which could damage the LED. In **common cathode** or **common anode** configurations (such as RGB LEDs or seven-segment displays), multiple LEDs share a common terminal.

### Applications of LEDs

LEDs are used in a wide range of applications, including:

- **Electronic Indicators** – Power indicators in devices, status lights, and signal lights.
- **Automotive Lighting** – Brake lights, turn signals, and headlights.
- **Display Panels** – LED televisions, billboard displays, and digital clocks.
- **Smart Lighting Systems** – Energy-efficient home and street lighting with dimming and color-changing features.
- **Medical Devices** – Pulse oximeters, phototherapy lamps, and endoscopy lighting.
- **Infrared Communication** – Used in remote controls, optical fiber communication, and security systems.