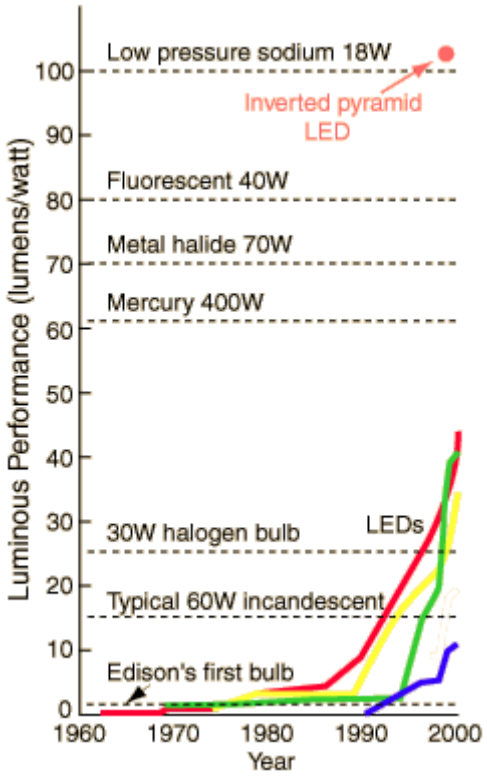
Light Sources in Electronics



Adapted from Craford, Holonyak & Kish, "In Pursuit of the Ultimate Lamp", Scientific American 284, Feb 2001, p63.

Light can be produced and/or controlled electronically in a number of ways. In light emitting diodes (LEDs), light is produced by a solid state process called electroluminescence. Under specific conditions, solid state light sources can produce coherent light, as in laser diodes. Other devices such as liquid crystal devices (LCDs) control externally supplied light to form display units. Liquid crystal projectors have made a major impact on public presentation of information, making inroads on the venerable cathode ray tubes. Other technologies such as the Texas Instruments' micromirror devices, called "digital light processors" as well as varieties of plasma displays are beginning to enter the market for displays.

Craford, et al. make the case that LED lighting is making great strides in power and efficiency and will play a more major role in general lighting. Some types last 100,000 hours, compared to about 1000 hours for an incandescent bulb. Now that blue LEDs have become a reality, white light LEDs can be produced by combining the red, green and blue chips in a single device.

The efficiency of a device in converting electrical power to visible light is called "luminous performance" in the illustration, and is measured in lumens/watt. Low pressure sodium lights have very high efficiency because of the dominance of the sodium d-lines in the response of sodium vapor. As a tribute to the progress which has been made with LEDs, one type of red LED, the inverted pyramid type developed by Hewlett-Packard has exceeded the efficiency of "old yellow", the sodium light.

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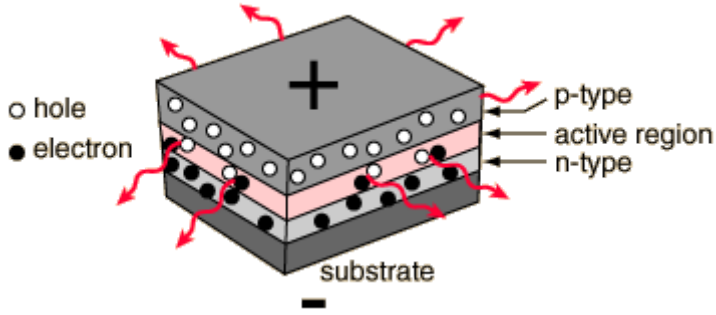
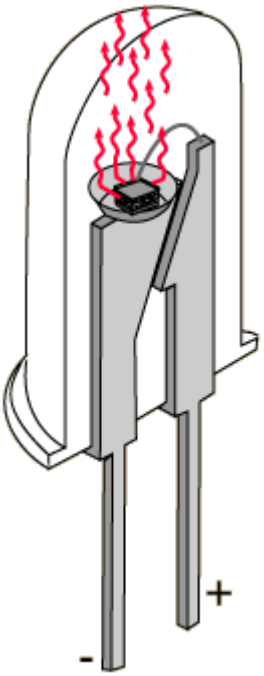
LED Device Structure





One way to constuct an LED is to deposit three semiconductor layers on a substrate. Between p-type and n-type semiconductor layers, an active region emits light when an electron and hole recombine. Considering the p-n combination to be a diode,then when the diode is forward biased, holes from the p-type material and electrons from the n-type material are both driven into the active region. The light is produced by a solid state process called electroluminescence.

In this particular design, the layers of the LED emit light all the way around the layered structure, and the LED structure is placed in a tiny reflective cup so that the light from the active layer will be reflected toward the desired exit direction.

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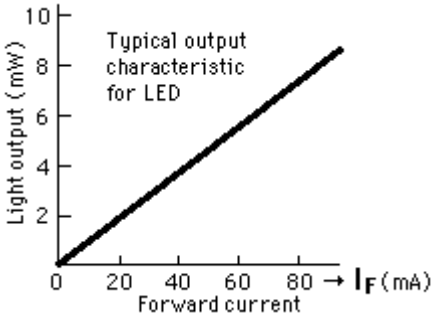
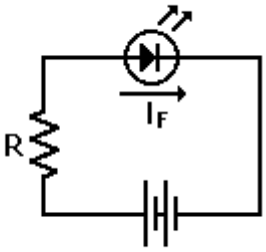
LED Characteristics

When an LED is forward biased to the threshold of conduction, its current increases rapidly and must be controlled to prevent destruction of the device. The light output is quite linearly proportional to the current within its active region, so the light output can be precisely modulated to send an undistorted signal through a fiber optic cable.





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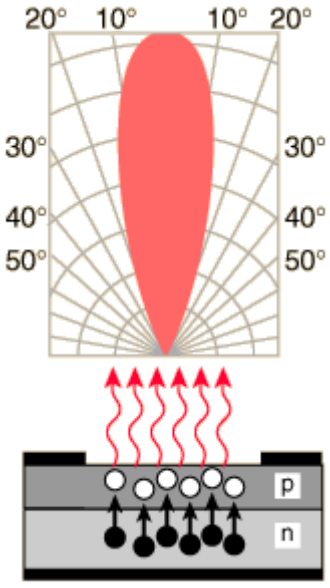
LED Radiation Patterns

An LED is a directional light source, with the maximum emitted power in the direction perpendicular to the emitting surface. The typical radiation pattern shows that most of the energy is emitted within 20° of the direction of maximum light. Some packages for LEDs include plastic lenses to spread the light for a greater angle of visibility.



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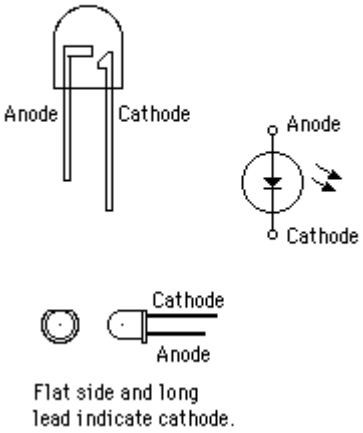
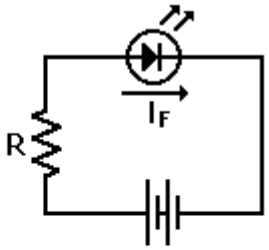
Light Emitting Diodes





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