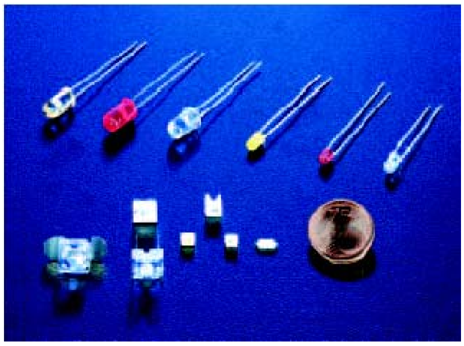
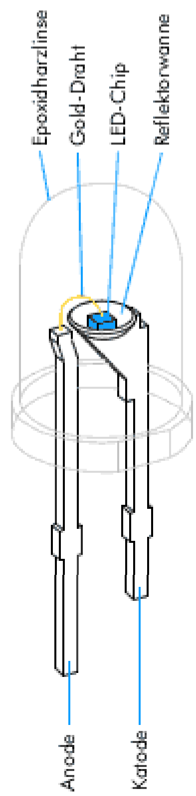
LED (Light Emitting Diode)

General points:



LEDs are replacing conventional bulbs in more and more vehicles. The technical advantages such as smaller size, longer service life etc. mean that LEDs are being used in more and more areas of automotive technology. This information examines in detail LEDs, their properties, and the range of applications.

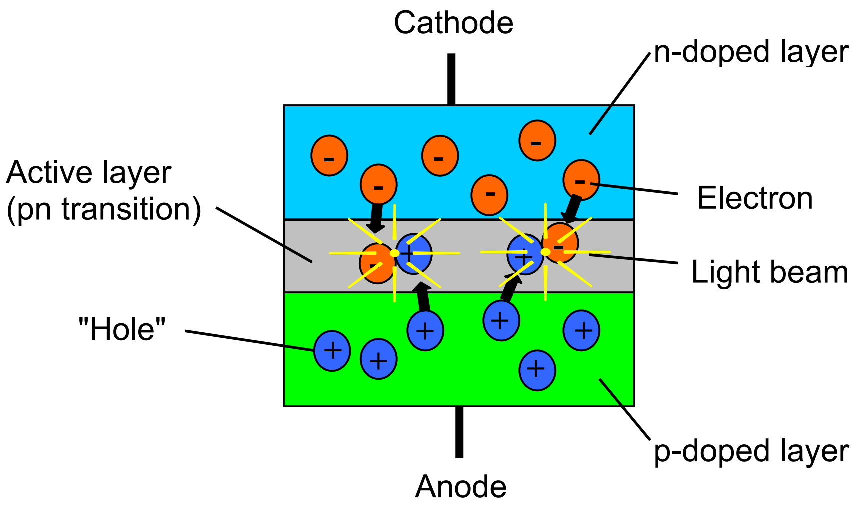
Structure:



An LED mainly comprises several layers of semiconductor connections. Semiconductors, such as silicon, for example, are materials that lie between conductors such as the metals silver and copper, and non-conductors (insulators) such as Teflon and quartz glass in terms of their electrical conductivity. The conductivity of semiconductors can be greatly influenced by the targeted inclusion of external materials with an electrical effect (doping). Together, these semiconductor layers form the LED chip. The light output (efficiency) of the LED and the colour of the light depends crucially on the composition (different semiconductors) of these layers. This chip is surrounded by a polymer (epoxy resin lens) which in turn is responsible for the radiation characteristics. In addition, it also serves to protect the diode. (In the illustration: Epoxidharzlinse = Epoxy resin lens, Gold-Draht=Gold wire, LED-Chip = LED chip, Reflektorwanne = Reflector pan, Anode = Anode, Kathode = Cathode)

Function:

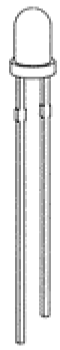
If a current flows through the LED in the flow direction (from the anode + to the cathode -) light is produced (emitted). The diagram below illustrates how the LED works:



The n-doped layer is prepared by including external atoms in such a way that there are surplus electrons. In the p-doped layer there are only a few of these charge carriers available. This leads to so-called electron gaps (holes). When an electrical voltage (+) is applied to the p-doped layer and (-) to the n-doped layer, the charge carriers move towards one another.
At the pn transition point, recombination occurs (particles with opposite charges are reunited into a neutral construct). In this process, energy is released in the form of light.

LED designs

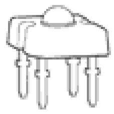
There are numerous LED designs available on the market. Alongside various metal and glass housings, polymer designs are also used. As well as protecting the LED, the polymer body is also responsible for the light output. The beam output is increased by the design, and the radiation angle, e.g. 30°, is determined by the lens-shaped surface.



3 mm LED

As well as the standard designs, 3 and 5 mm, so-called SMD LEDs are also available. These differ from the standard form particularly in terms of their miniaturisation and smaller design height. The special design also allows operation with higher currents, thus increasing the illuminance.
In the case of the "Super Flux LED", the heat caused by the higher current is dissipated via additional solder contacts, or as with the "Barracuda", via a cooling sheet on the underside of the LED. These LEDs are used in particular for lighting.

SMD LED



"Super Flux" Spider LED

"Barracuda" LED

LED service life

In the case of standard LEDs, service lives of at least 100,000 hours are currently being achieved. This corresponds to $11^{1}/_{2}$ years of uninterrupted service life. In the case of high-power LEDs, the service life is somewhere between approx. 25,000 and 50,000 hours. High or fluctuating temperatures also shorten service life. For this reason, thermal and mechanical stress should be kept as low as possible during repairs, e.g. when soldering a new LED into place.

Light diodes work with operating voltages between 2 V and 4 V. They are operated at 20 mA. In the case of "Super Flux" and "Barracuda" LEDs, the operating current is between 70 mA and 300 mA. The current flowing through the diode depends on the voltage applied. If the voltage is applied is too high, it will destroy the diode. However, this is prevented by polarity inversion protection and excess voltage protection. The polymer bodies of the LEDs also become somewhat cloudy with time, which reduces their effectiveness.

Comparison LED – filament bulbs:

The degree of effectiveness of a light source is specified in Lumen per Watt. Some examples:

Filament bulb	10 – 15 lm/W
Halogen bulb	15 – 25 lm/W
Energy-saving bulb	50 – 65 lm/W

Degree of effectiveness of the brightest LEDs currently being mass-produced:

red – orange	45 – 55 lm/W
red	35 – 45 lm/W
green	35 – 45 lm/W
white	20 – 25 lm/W
blue	8 – 10 lm/W

Advantages of LEDs

- Higher degree of effectiveness and therefore lower power consumption
- Low build-up of heat
- No maintenance costs
- Small design shape, miniaturised SMD versions
- Individual shaping of the light source thanks to different arrangements of the LEDs
- Impact and vibration proof (vehicle technology)
- No bulb holders necessary

Disadvantages of LEDs

- A large number of LEDs is necessary to achieve the illuminance of conventional light sources
- Relatively high unit costs
- Colour reproduction of a white LED is not sufficient in all areas of application