



Epigap FAQs

Part 4

4. handling

4.1. biasing LEDs

The light generated by an LED is directly proportional to the forward current flowing through the device. Various biasing schemes can be used to set the value of the current. Some are illustrated below.

4.2. electrical circuit

example: How to make 15...20 mA flow through the LED:

First you need to know the LED forward voltage. You can find the exact values in data sheets. If there is no data sheet available it is safe to assume:

3.6 V for UV 355...375 nm LEDs,
3.2 V for 395...525 nm violet, blue, blue-green, green and white LEDs,
2.1 V for high-brightness yellow and orange LEDs,
1.8 V for high-brightness red and deep red LEDs.

Do not drive LEDs with a current above maximum rating. Use favourable cooling conditions. Some LEDs current ratings assume some really favourable test conditions - such as being surrounded by air no warmer than 25 degrees Celsius and some decent thermal conduction from where the leads are mounted. You can use somewhat higher currents if you can tolerate much shorter life expectancy.

Next, know your supply voltage. It should be a few volts above the LED forward voltage for reliable, stable LED operation

Next step is to subtract the LED voltage from the supply voltage. This gives you the voltage that must be dropped by the dropping resistor. Example: 3.4 volt LED with a 6 volt supply voltage. Subtracting these gives 2.6 volts to be dropped by the resistor.

The next step is to divide the dropped voltage by the LED current to get the value of the dropping resistor. If you divide volts by amps, you get the resistor value in ohms. If you divide volts by milliamps, you get the resistor value in kilo-ohms.

Example: If you want to operate the 3.4 volt LED from a 6 volt power supply at the LED's typical current of 20 mA, then 2.6 divided by 0.02 yields a resistor value of 130 ohms. The next higher popular standard value is 150 ohms.

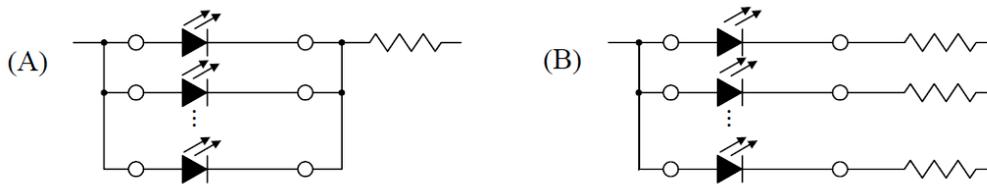
You also have to check the resistor wattage. Multiply the dropped voltage by the current to get the wattage being dissipated in the resistor. Example: 2.6 volts times 0.03 amp (30 milliamps) is 0.078 watt. For good reliability, we recommend not exceeding 60 percent of the wattage rating of the resistor. A 1/4 watt resistor can easily handle 0.078 watt.

You can put LEDs in series with only one resistor for the whole series string. Add up the voltages of all the LEDs in the series string. This should not exceed 80 percent of the supply voltage if you want good stability and predictable current consumption. The dropped voltage will then be the supply voltage minus the total voltage of the LEDs in the series string.

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Do not put LEDs in parallel with each other. Although this usually works, it is not reliable. It is recommended to use circuit B which regulates the current flowing through each LED separately. In the opposite: When driving LEDs in circuit A with a constant supply voltage, the current through the three different LEDs may vary due to the variation in forward voltage (V_F) of the LEDs. In the worst case, some LED may be subjected to stresses in excess of the absolute maximum rating.



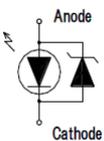
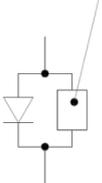
4.3. reverse voltage

LEDs should be operated in forward bias. A driving circuit must be designed so that the LED is not subjected to reverse voltage. LEDs also should not be exposed to any voltage while there is no current flow. This could cause electro migration resulting in LED damage.

4.3.1. How to protect LEDs against reverse voltage / electrostatic discharge?

Electrical protection against reverse voltage is recommended, especially for UV LEDs. Simple low-current antiparallel connected Si diode or low-voltage Zener diode can be used. Red low-current LEDs are also sometimes used. One can therefore see warning red radiation if reverse voltage is accidentally applied.

Protection device



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4.4. operating temperature range of LEDs

Manufacturers provide in data sheets an operating temperature range like $-40^{\circ}\text{C} \dots +85^{\circ}\text{C}$ and storage temperature range like $-40^{\circ}\text{C} \dots +100^{\circ}\text{C}$ for the complete component. This temperature range is determined by both the LED chip and the package.

The minimum allowed temperature is generally defined by materials used, as the main problem are different coefficients of thermal expansion (CTE) of various materials.

The maximum (operating) temperature is usually defined by the maximum allowed junction temperature of the chip.

4.5. burn-in

Burn-in is an art of preconditioning, the process by which components of a system are exercised prior to being placed in service (and often, prior to the system being completely assembled from those components). This testing process will force certain failures to occur under supervised conditions so an understanding of load capacity of the product can be understood.

The intention is to detect individual components that would fail as a result of the initial, usually higher high-failure rate. If the burn-in period is made sufficiently long (and, perhaps, artificially stressful), the system can then be trusted to be mostly free of further early failures.

It is better to eliminate the root cause of early failures than doing a burn-in. A production process that initially uses burn-in may eventually phase out as the various root causes for failures are identified and eliminated.

For electronic components, burn-in is frequently conducted at elevated temperature and perhaps elevated voltage. The components may be under continuous test or simply tested at the end of the burn-in period.

Source: Wikipedia.

Burn-in can also be used to stabilize output power and forward voltage of LEDs. The optimal time for burn-in differs. A commonly used burn in time is 100 hours.

4.6. electrostatic discharge (ESD)

4.6.1. measures against electrostatic discharge

LEDs, especially on GaN base, are sensitive to static electricity or surge voltage. ESD can damage the chip. When handling LEDs the following measures against electrostatic discharge are strongly recommended:

- proper grounding is required for all devices, equipment and machinery used in product assembly and measurement
- ESD table made of conductive materials
- grounded wrist strap, ESD footwear, clothes and floors
- neutralizing charge by ionizing or moistening the surrounding air

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4.6.2. How to detect ESD damaged LEDs?

Damage can be detected with a forward voltage measurement at low current (≤ 1 mA). ESD damaged LEDs may have a lower forward voltage than specified and have a current flow at this low forward voltage.

Failure criteria (example): $V_F < 2.0$ V at $I_F = 0.5$ mA for 365 nm UV LEDs.

4.7. degradation of LEDs on forward current

Degradation rate depends strongly on the LED forward current. The higher the current, the quicker the degradation.

4.8. criteria for judging damage

Besides catastrophic damages, there are other criteria for judging damage that are often used:

Test item	Symbol	Measurement conditions	Judgment criteria	
			Min.	Max.
Forward voltage	V_F	$I_F = 20$ mA	-	U.S.L.* x 1.1
Reverse current	I_R	$V_R = 5$ V		U.S.L.* x 2
Luminous intensity	I_v	$I_F = 20$ mA	L.S.L.** x 0.7	
Output optical power	Φ_e	$I_F = 20$ mA	L.S.L.** x 0.5	

*U.S.L. - Upper Standard Level,

**L.S.L. - Lower Standard Level

4.9. cleaning of LEDs

LEDs should not be cleaned. Cleaning agents should be tested prior to use whether they will affect the LED package.

Ultrasonic cleaning is not recommended since it may have adverse effects on LEDs.

4.10. safety precautions when using LEDs

4.10.1. Toxicity

Although gallium arsenide and gallium aluminium arsenide are both arsenic compounds, under normal use conditions they should be considered relatively harmless. Both materials are listed by the 1980 NIOH "Toxicology of Materials" with LD50 values (lethal doses, probability 50%) comparable to common table salt.

Accidental electrical or mechanical damage to the devices should not result in a toxic hazard, so the units can be applied, handled etc. as any other semiconductor device. Although the chips are small, chemically stable and protected by the device package, conditions that could break these crystalline compounds down into elements or other compounds should be avoided.

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4.10.2. eye safety

As the radiant output power of individual LED chips and multi-chip LED arrays continues to increase there is growing concern over the potential risk of eye damage.

Of course, the vast majority of LEDs are completely safe and do not represent any hazard to the human eye. The latest generation of LEDs is not always safe, and someone will have their eyes damaged by a high-power LED product. The properties of some LEDs are so close to those of lasers that they could be dangerous.

The International Electrotechnical Commission (IEC) treats LEDs as lasers. In contrast, the International Commission on Illumination (CIE) treats LEDs as lamps, which are extended (rather than point) sources that generally have widely divergent beams. The CIE and IEC approaches (lamp or laser) generally don't produce the same results for the same product.

The optical output power of an LED source is important, but it's also necessary to measure the **apparent source size**, rather than the beam diameter. Important is the size of the image formed on the retina, since a larger image relates to a lower power density.

UV LEDs radiate intense UV light during operation. Since UV light can be harmful to eyes, do not look directly into the UV light. UV protective glasses are required in order to avoid eye damage by direct or reflected UV radiation.

IR LEDs might also be dangerous for eyes. Their radiation is not visible

Regardless of LED color we advise users to not look directly at any operating LED component.

4.11. Recommendation for long term storage of LED chips

transport and storage in anti-electrostatic, moisture-proof aluminum bag with desiccants (silica gel); chips on adhesive film (blue tape) with wire bond side up

storage conditions:
temperature +15°C...+30°C
relative humidity (RH) 40%...60 %
protected from UV light and dust
in chambers under nitrogen atmosphere
no mechanical stress

In case of storage for more than two years, it is recommended to repack the chips.

For long time storage contact the component producer.