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Dialight
Signals & Components

WHITE PAPER

ESD IMPACT ON LEDS... IT CAN BE MORE SERIOUS THAN YOU SEE!

Choosing the proper SMT LED for your application can provide additional safeguards against the impacts of electrostatic discharge during assembly and in the field.

We have all been there, it is a cool winter night, the heat is blazing, you walk across the room to turn on the light and ZAP. You have just experienced several 1000 volts from an electrostatic discharge (ESD). While I am sure most of us have survived this several hundred if not thousands of times, your LEDs may not be so fortunate.

ESD can range from a few hundred volts to 10's of thousands of volts. In terms of ESD sensitivity, not all LEDs are created equal. LEDs today are made in several different ways the most common being GaP, AlInGaP, and InGaN technologies. GaP and AlInGaP LEDs tend to have a higher resistance to ESD damage, InGaN technology, used to make, high bright green, blue, white and phosphor converted (PC) amber LEDs can be very sensitive to ESD damage.

WHY DO LEDs FAIL FROM ESD?

When exposed to an adverse ESD event, LED damage can occur in several ways. An ESD event results with a high transient discharge into the device. This transient will create a large short-duration peak current with an associated high-energy release, bringing with it potential permanent damages to the components. These transients can create additional defects in the LED die due to localized high thermal dissipation and electrical conduction. Depending on the level of the ESD event the failure of the LED may be immediately catastrophic or a subtle degradation of the LED that results in a deterioration of the LEDs' performance at a faster than expected rate.

The catastrophic failure typically will result from larger transient events and create physical damage to the LED chip. In the case of catastrophic damage, while the damage site may be microscopic as shown in figure 1 below, the LED will fail to emit light and act more like a short circuit.

When an LED suffers damage from a smaller transient event, the LED may still appear to function normally but over time will degrade significant quicker due to minor damage to the LED that affects the ability of the LED to conduct forward current and /or an instability of the reverse bias characteristics of the LED.

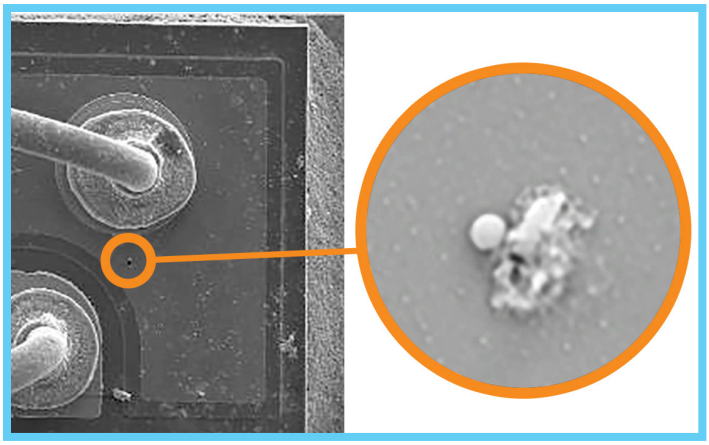


Figure 1. Typical ESD Damage

CHARACTERIZING ESD

Multiple standards exist to better understand and test a devices ESD susceptibility. The specifications address machine models, charged device models and human-body models (HBM). For the characterization and testing of LEDs, the industry typically utilizes the HBM procedure. HBM test levels range from <250 volts to as high >8000 volts. The voltages at which ESD damage is likely to occur in a device define HBM classification for the component. Table 1 shows the classification levels and voltages.

Class	Voltage Range
Class 0	< 250 volts
Class 1A	250 volts to < 500 volts
Class 1B	500 volts to < 1000 volts
Class 1C	1000 volts to < 2000 volts
Class 2	2000 volts to < 4000 volts
Class 3A	4000 volts to < 8000 Volts
Class 3B	≥8000 Volts

Table 1. Human Body Model ESD Classification

Level zero being the most sensitive. To put this in perspective, according to data from the ESD association, in a room with 65% to 90% relative humidity, walking across a carpet can generate a potential of 1500 Volts, while picking up a poly bag from a workbench can create a 1200 Volt potential discharge. In a room with 10% to 25% relative humidity, these potentials change to 35,000 Volts and 20,000 volts respectively.

SOURCES OF ESD

Potential exposure of an LED to an ESD event can happen in many different ways. In the production environment, if proper precautions for handling ESD sensitive components are not in place, risk of damage to the LED by ESD occurs during the process of removing the LED from the packaging and placing it either on the board or in a container that is not proper grounded.

Additionally, in today's ever-growing environment of hand held and wearable devices, LED damage can occur in much the same way that you experience a shock turning on the lights on a cold winter night, the human body builds up a charge and it is discharged into the hand held or wearable device.

PROTECTING FROM THE TRANSMISSION OF ESDs

There are many papers discussing manufacturing precautions for protection from ESDs. They include the proper grounding of equipment, grounding of workstation, use of wrist straps or other mean to reduce the buildup of an electric charge in a person handling the products as well as anti-static floor treatments.

Wrist strap used to reduce the buildup of electric charges in a person

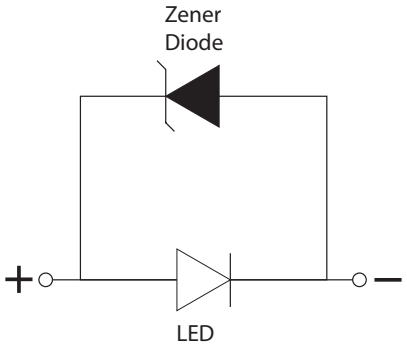
All these method, when properly utilized, have proven records of success. The result is the manufacturer's high confidence in their products provided to the customer. However, what happens if proper safeguards are not maintained in manufacturing? What happens after the product get to the end user? If the product fails prematurely it can easily tarnish the manufacturer's reputation.

Fortunately, for LEDs there is a solution to address the transmission of ESDs.

Dialight offers select 597 series SMT LED products that provide an ESD level 2 protection, 2000 volts to < 4000 volts.

Level 2 protection is the accepted level in manufacturing environments with proper ESD controls. It is also acceptable for most finished products, as the finished product's outer case or chassis will also dissipate some of the ESD transient.

These products incorporate in integral Zener diode chip, sometimes referred to as a transient voltage suppressor (TVS) in parallel to the LED chip.



A Zener diode is a semiconductor device designed to withstand very high level of transient voltages and clamp the resulting voltage in the zener to a specific design voltage.

For a zener diode used in this application, that voltage is typically 3.5 to 3.9 volts. By connecting the zener diode in parallel to the LED chip, the voltage across the LED chip is limited to the same voltage as the zener diode.

When exposed to an ESD transient, the LED with a zener diode absorbs the energy of the transient in the zener diode and keeps the voltage across the LED to a 3.5 to 3.9 volt level, protecting the LED chip from damage. This provides protection to the LED in both the production environment as well as in the final product.

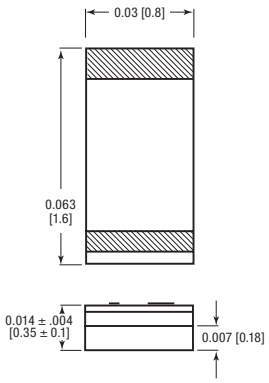
The overview below details the LED products currently available from Dialight that contain Level 2 ESD protection.

597 Series 0603, 0606, 0805, 1206 with integral Zener Diode

- Transient voltage suppressor
- Human Body Model Class 2 ESD protection

0603

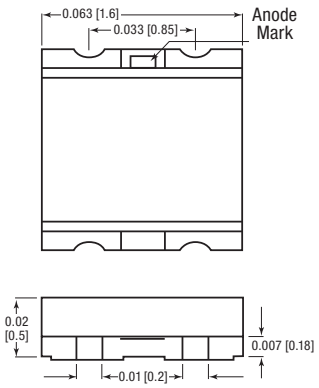
○ White (x+0.295, Y=0.280)



Part# 597-3905-607F

0606

TriColor
● Red (630 nm) ● Green (527 nm)
● Blue(470 nm)



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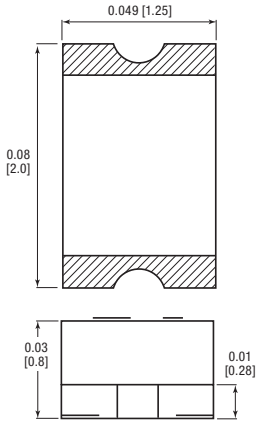
0805

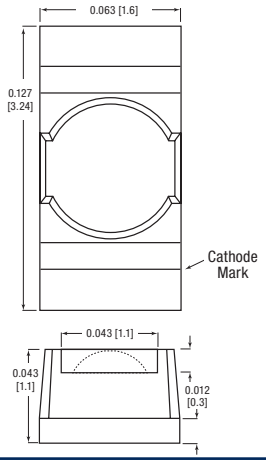
● Blue (470 nm)



Part# 597-3605-607F

1206 - Reverse Mount

● Green (527 nm)



Part# 597-6325-607F

Dialight is the world-leading supplier of Optoelectronic components. We are the leader in LED board-level through-hole and surface mount indication, including Prism® SMDs and Optopipe® Light Pipes.
Combined with our LED panel mount line and based LED bulbs, Dialight offers the widest range and most reliable of indicator products.

OE is Our Expertise!