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## Electrostatic Discharge (ESD) in LED Electronic Devices

### INTRODUCTION

#### Definition of Static Electricity and Electrostatic Discharge (ESD):

*Static electricity* is defined as an electrical charge caused by an imbalance of electrons on the surface of a material. This imbalance of electrons produces an electric field that can be measured and that can influence other objects at a distance. *Electrostatic discharge* is defined as the transfer of charge between bodies at different electrical potentials.

(Note: Poor bonding and grounding allows bodies that are meant to be at the same “0” voltage reference electrical potential (voltage) to be at different electrical potentials (potential difference) allowing unwanted and potentially damaging charge transfer.)

“Controlling *electrostatic discharge* begins with understanding how *electrostatic charge* occurs in the first place.”

#### Examples of Electrostatic Charge:

“Electrostatic charge is most commonly created by the contact and separation of two materials. For example, a person walking across the floor generates static electricity as shoe soles contact and then separate from the floor surface. An electronic device sliding into or out of a bag, magazine or tube generates an electrostatic charge as the device’s housing and metal leads make multiple contacts and separations with the surface of the container. While the magnitude of electrostatic charge may be different in these examples, static electricity is indeed generated.” 1

#### Typical Static Generation:

“Basically, ESD falls into two categories: protection during manufacturing and protection in the ‘real-world’ environment. **The level of ESD the end user can generate and introduce to the electronic device is much more severe** than the level found in the controlled manufacturing environment. It’s important to remember that survival through the manufacturing process does not guarantee survival in the hands of the end-user.”

Means of Generation	Typical Voltage Levels (Dependent on Relative Humidity)	
	10 – 25 % (RH)	65 – 90 % (RH)
Walking across carpet	35,000V	1,500V
Walking across vinyl tile	12,000V	250V
Worker at bench	6,000V	100V
Poly bag picked up from bench	20,000V	1,200V
Chair with urethane foam	18,000V	1,500V

**TABLE 1 –Examples of Static Generation**

It should be understood that, “many ESD events occur without a visible or audible spark. A person carrying a relatively small electric charge may not feel a discharge that is sufficient to damage sensitive electronic components. Some devices may be damaged by discharges as small as 12 volts. These invisible forms of ESD can cause device outright failures, or less obvious forms of degradation that may affect the long term reliability and performance of electronic devices. The degradation in some devices may not become evident until well into their service life.”

### Damages Caused By ESD

LEDs can be damaged so badly by ESD that they experience a catastrophic failure. This means they do not emit light. They may short or open (no longer electrically conductive). If an LED becomes damaged but is still electrically conductive, this is considered a latent defect.

### Catastrophic Failure:

An LED or electronic device that has completely failed as a result of ESD remains completely dark. Typically, all of the LEDs in a single coupon are connected in series. If it fails open it is no longer electrically conductive. Consequently, even if the other components are undamaged, all other LEDs in the series connection will not light. If it fails shorted, only that one LED will not light. The rest of the string will appear to continue to function. Depending on the design configuration, this may put a strain on the rest of the components. This may be visible immediately after the damage occurs.

### Latent Defect:

A latent defect, on the other hand, is more difficult to identify. A device that is exposed to an ESD event may be partially degraded, yet continue to perform its intended function. However, the operating life of the device may be reduced dramatically. A product or system incorporating devices with latent defects may experience premature failure after the user places them in service.”

(Note: most damages become visible after a short period of operation. We recommend a function test of approximately 1 hour and a burn-in of 48-72 hours, particularly for installations with difficult access.)

### ESD PREVENTION – Damages

#### Where to Take ESD Preventative Measures:

Everyone who is handling ESD sensitive devices has to be aware of ESD protection. Installers and in-store personnel need education and training with ESD focus. ESD preventive measures must be taken in all of the departments where ESD sensitive devices are held. This includes:

- ESD focused design and engineering review prior to manufacturing
- Need for adequate shielding, grounding, filtering written into specifications for RFQ.
- Incoming inspection
- The manufacturing line
- Testing/outgoing inspection
- Packaging
- Storage/Warehouse
- Shipping
- Installation
- Maintenance

#### Static Protection Basics:

ESD damage can be caused by contact with non-conducting insulating materials, such as internal packaging material intended to protect components (like plastic bags). These materials can become statically loaded during handling. ESD damage can be caused simply by contact with such materials. The same can be said for human contact. People who carry charge on their clothing and person that discharges through components they handle are one of the major causes of ESD failures.

#### Grounding:

Grounding is a very important measure. **Grounding Systems are used to ensure ESD items, personnel and any other conductors are at the same electrical potential.** All manufacturing and installation personnel need to be bonded or electrically connected to the ground or contrived ground when handling ESD sensitive items.

- Grounding with the help of a special reel
- Conductive footwear
- Heel bands should be worn on both feet in order to ensure constant contact to the ground.

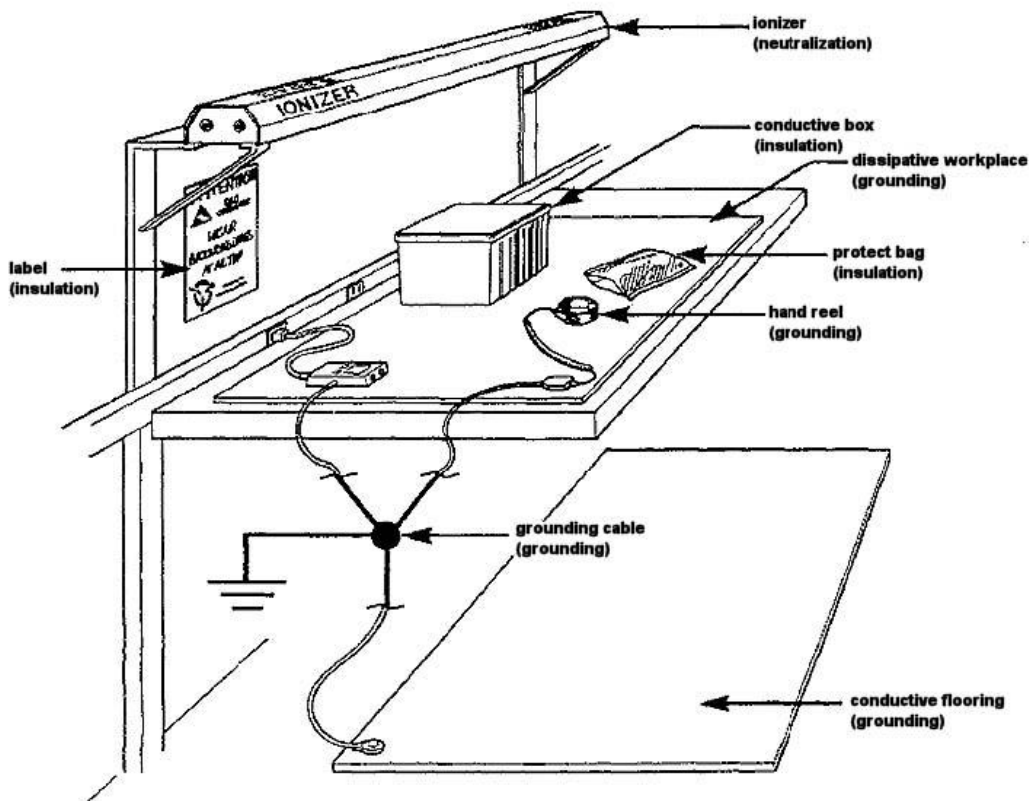


Make sure you are grounded before handling ESD sensitive components.

**Neutralization:**

An Isolator (electrically conducting shield device), while protecting the components it is isolating, can accumulate charge over time. In order to reduce this risk, any static charge on the isolator must be neutralized. **Neutralization does not replace grounding or prevention!**

**FIGURE 7**



**Prevention:**

General:

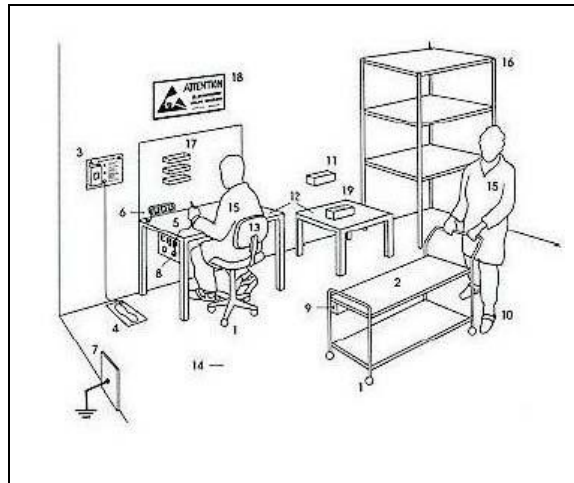
- When entering an ESD protected area or handling ESD sensitive parts, use appropriate safety precautions.
- Soldering irons, screwdrivers and other tools should be ESD certified and recognizable from the ESD protected symbol. (Ref. Figure 10 )
- Grounds and grounding devices should be tested regularly.

For LED Systems:

- When handling, or transferring modules from one person to another, wear grounding cotton gloves. (Ref. Figure 11)
  - It also
- Avoid touching metallic contents.
- We recommend using a spray lacquer for ESD safe lacquering. (Ref. Figure 12)
- Modules should be separated (should not touch each other) during storage and transport.
- Do not let components and/or modules come into contact with clothes, hair or other insulators. (e.g. carpet)



**FIGURE 11**



**FIGURE 14 – ESD Protected Area**

- |                                   |   |                                     |
|-----------------------------------|---|-------------------------------------|
| 1. Grounded wheels                | 8. Earth bounding point (EBP)           | 14. Floor                           |
| 2. Grounded surface               | 9. Grounded point of trolley            | 15. Garments                        |
| 3. Wrist band and footwear tester | 10. Toe and heel strap (footwear)       | 16. Shelving with grounded surfaces |
| 4. Footwear footplate             | 11. Ionizer                             | 17. Grounded racking                |
| 5. Wrist band and grounding cord  | 12. Dissipative surfaces                | 18. EPA sign                        |
| 6. Grounding cord                 | 13. Seating with grounded feet and pads | 19. Machine                         |
| 7. Ground                         |   |                                     |

The consideration of these measures reduces the occurrence of ESD damages, but cannot exclude them completely.

References:

- Osram-Sylvania Application Notes  
Electrostatic Discharge Association; <http://www.esda.org/>  
Electronic Design; <http://electronicdesign.com/Articles/Index.cfm?ArticleID=3727>  
Electrostatic Discharge, Wikipedia; [http://en.wikipedia.org/wiki/Electrostatic\\_discharge](http://en.wikipedia.org/wiki/Electrostatic_discharge)