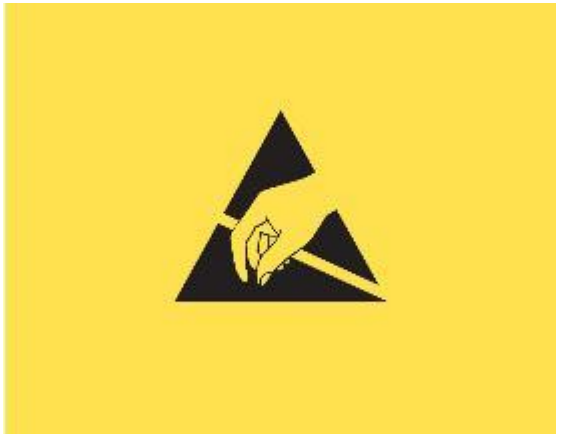
ESD Training



Aims and Purpose:

- The aim of this training is to understand what Electrostatic Discharge is, what risk it poses and what you can do to mitigate the risk of electrostatic discharge (E.S.D).

- The purpose of the presentation is to understand how to manage ESD in line with the British Standard: BS EN 61340-5-1.

What Is Static Electricity?

- A stationary electric charge, typically produced by friction, which causes sparks, crackling or the attraction of dust or hair.

- All items are made of small atoms. These atoms are made up of even smaller items called protons, neutrons and electrons. The protons are charged positive, the neutrons have no charge and the electrons are charged negative.

- Under normal conditions, there are the same amount of protons and electrons giving atoms no charge.

- However, these electrons can move. When separating or rubbing together materials, electrons can move from atom to atom or from one material to another (triboelectric charges). This can mean that atoms can hold a positive or negative charge. (Dependant on movement and direction of electrons). If the material in question is an insulator, this charge can be held and not move. This is called static electricity.

What Is Static Electricity?

- The rapid movement or decay of these charges can cause expensive problems, whether it is huge and dangerous charges such as lightening or simply an annoying (and sometimes painful) “electric shock” when touching a filling cabinet or when getting out of a car. (These charges are normally on you!).

- These charges can be a huge problem for small sensitive electronic devices. Some devices can be damaged or destroyed by as little as 10 volts. Charges on your body simply by walking or even sitting at your chair can be in excess of 5000 volts (human body material). This is because of items of clothing rubbing together or as simple as shoes separating from the ground.

- When items are insulators such as carpets, charges are much higher – imagine the damage this could cause. This is why it is important that insulators should be avoided and all possible static electricity generators (such as you) should (must) be grounded to eliminate any build up of charges.

What Is Static Electricity?

At what point do you hear static?

- 2000+ Volts.

At what point do you feel a static shock?

- 3000+ Volts.

At what point do you see static?

- 5000 Volts.

What voltage can damage components?

- Can be as little as 10 volts depending on the size, sensitivity and type of component.
- To comply with the British standard, 100V is the maximum threshold that can be produced within an EPA.

What Is ESD?

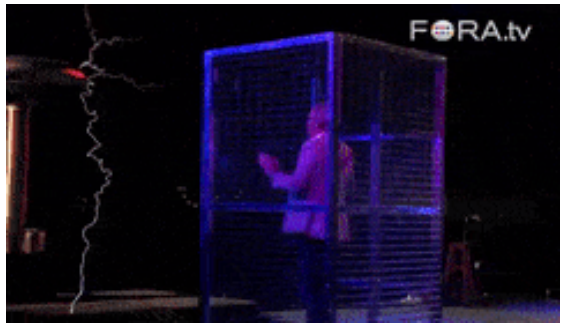
Introduction

Static electricity has been an industrial problem for centuries. As early as the 1400's, European forts were using static control procedures and devices to prevent electrostatic discharge igniting gun powders and other explosives.

Terminology

- **ESD:** Electrostatic Discharge. An uncontrolled surge of "static" between objects with different voltage potentials.
- **Static:** An electrical charge / field that isn't moving.
- **EPA:** Electrostatic Protected Area. A static safe handling area which could be a bench, a room or any other designated area, which should not have any "static field" greater than 100v maximum.
- **Antistatic:** Minimal generation or retention of a "static" charge.
- **Conductive:** Low resistance i.e. less than 1 Meg-ohm (10^6) – the closer to 1 Meg-ohm, the slower the discharge.
- **Static Dissipative:** Increased resistance, which protects better against an ESD i.e. between 1 Meg-ohm ($10^{6)}$ and 1000 Meg-ohm (10^9).

What Is ESD?



Terminology

- **Insulative:** Does not allow the free flow of electrons, therefore, it will more than likely cause problems e.g. prevent a path to earth, hold a “static” field, etc.
- **Faraday Cage:** A conductive barrier against ESD e.g. Metalised Shielding Bag, Conductive Box etc.
- **Tribocharge:** To generate “static” by the rubbing or separating of surfaces.

Potential Difference

Potential difference causes ESD when there is a difference in charge between two objects:

- Work surfaces
- Articles of clothing
- People
- Flooring
- Shelving / conveyers

What Is ESD?

ESD Overview

- **Within today's electronics industry, it is widely accepted that Electro-Static Discharge (ESD) events are a significant cause of device failure and that implementing static control measures is not only desirable but essential.**
- Damage to this industry has been estimated at billions of dollars annually. However, while the costs of static control measures can be high, the return on investment certainly does justify the implementation of such measures.
- ESD problems have magnified during the past 3 decades because of 2 reasons:

1) The increased use of insulating man-made fibre's and plastics for clothing, furnishing, flooring etc.

2) The ever-increasing sensitivity of integrated circuits due to smaller and smaller conductors and components within the circuitry.

- ESD can change the characteristics of a semi-conductor device, degrading or destroying it. Controlling ESD begins with understanding how electrostatic discharge occurs in the first place. Electrostatic charge is most commonly created by the contact or separation of two materials. This is known as "triboelectric charging", it involves the transfer of electrons between materials.

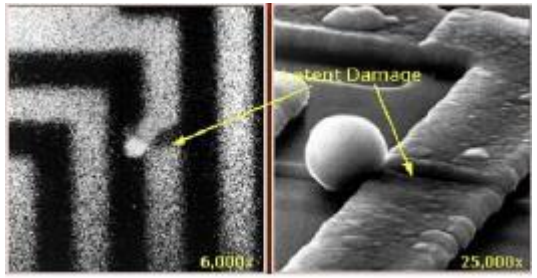
What Is ESD?

Damage Classification

Electrostatic damage to electronic devices can occur at any point from manufacture to field service. Damage results from handing the devices in uncontrolled surroundings or when poor ESD control practices are used. Generally damage is classified as either a catastrophic failure or a latent defect.

Catastrophic Failure

When an electronic device is exposed to an ESD event it may have caused a metal melt, junction failure or oxide breakdown, permanently damaging its circuitry and resulting in failure. Such failure can usually be detected when the device is tested before shipping. If the ESD event occurs after the test the damage will go undetected until the device fails in operation.



Latent Damage

A latent defect is much more difficult to identify. A device may be partially degraded yet continue to perform its intended function. However, the operating life of the device maybe reduced dramatically. This could cause premature systems failure which could prove extremely hazardous and very costly.

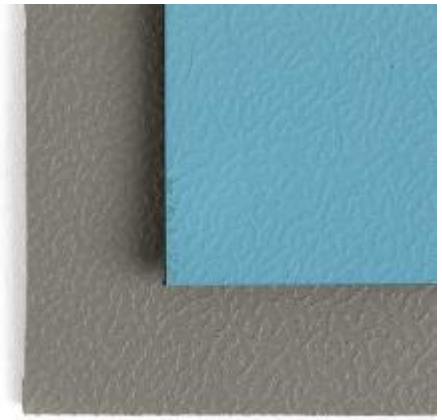
What Is An EPA?

EPA Overview

EPA Equipment

ESD Mats and Flooring

- Mats and ESD Flooring dissipates charge through the top layer (dissipative layer) of the mat, travels through to the conductive layer and through the stud to earth.



Wrist-Straps and Cords

- Wrist Straps: carry the charge away from the person and discharge the static safely to ground. The cables are always fitted with a 10^6 Ω resistor next to the skin. The Cables are usually connected to earth through a stud on a mat or straight to an earth bonding point.

Heel Grounders and ESD Shoes

- Heel grounders and ESD Shoes work in a similar way only pass the charge into an ESD Floor

EPA Equipment

Wrist-Straps and Cords

A wrist-strap is the most effective method of bonding an operator to ground when mobility is not an issue. It discharges the static being generated on the body to ground instantly.

Wrist-straps must be worn while sitting, even when E.S.D. footwear is being used.

Straps should be clean, snug and comfortable. If your strap is loose and/or dirty, you run the risk of having an intermittent contact to ground.

Coil cords should have a 1 meg-ohm safety resistor in the snap that attaches to the wrist-strap. The strain relief should be intact and the coil tight so that it doesn't hang and catch too easily.

The outer surface of the wrist-strap should be insulative for operator safety.

ESD Footwear

ESD shoes, heel and toe straps are effective methods of grounding operators when mobility is an issue, but, only if used in conjunction with flooring that can be bonded to ground. (i.e. matting, tiles, resin, coatings etc.).

When wearing heel or toe straps, there should be a strap on each foot in order to ensure the best possible contact to ground when walking and standing. Whether the "earthing ribbon" fits under your foot or inside your sock it doesn't matter, as long as the contact is a good and reliable one.

When sitting, wrist-strap must also be worn.

Why Do You Need To Check Wrist-Straps And Heel Grounders?

You are checking the continuity of the path through to earth from the person. It also measures the resistance through the hand and ground to ensure that it has a resistor in and protects the wearer.

Failures can occur through:

- Contact with skin
- Cord damage

Testing is very important because:

a) 0.9 meg-ohm is checking that you don't have a short circuit to ground, which could be dangerous. It has been calculated that 0.75 meg-ohm will offer protection against 250v a.c. (500v d.c.).

b) 35 meg-ohm ensures that you are not too resistive to ground.

If you fail a test, don't try and fiddle it, find out what's wrong. For example, Damaged? Dirty? Dry skin? No resistor?

Cheating the test is your responsibility.

Bags and Packaging

Which one and when?

Using the correct packaging and materials not only protects your static sensitive components, but it can save money too!

Which of the three bags are anti-static?

- **Pink Bag** is anti-static or low charging – Should not be used for ESDS. Whilst they don't produce static, a charge can pass through the bag itself.

- **Shielding bags** are ESD and protect the internal ESDS from any external charge, working as a faraday cage.

- **Black** are conductive – they will drain batteries and generally not used.

Bags and Packaging

- **Insulators** charge up and are not capable of discharging as do not conduct electricity, although the charge will decay.
- **Conductive boxes** work as a faraday cage, they shield the ESDS inside due to the thickness of the conductive material. These generally have conductive foam on the inside.

- **IC Tubes** generally are ESD. They have an ESD coating which can become compromised after usage and as such are for a single use.
- **ESD Bubble wrap** is much like the pink bags and is Low charging bud doesn't act a shield.

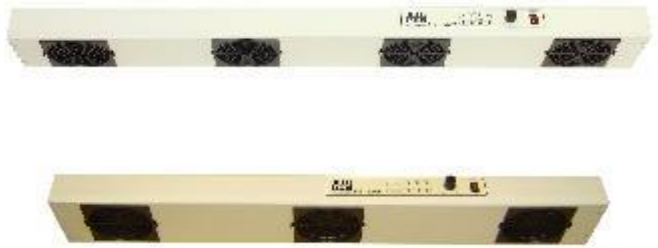
Workstation Items

Hand Tools

All **hand tools** used in an EPA should have static-dissipative handles. Normal insulating handles can generate high voltages. (Usually in the centre of the EPA).

Ionizers

Ionizers generate positive and negative ions which neutralise any static charges on insulating materials which cannot be grounded in the normal way.

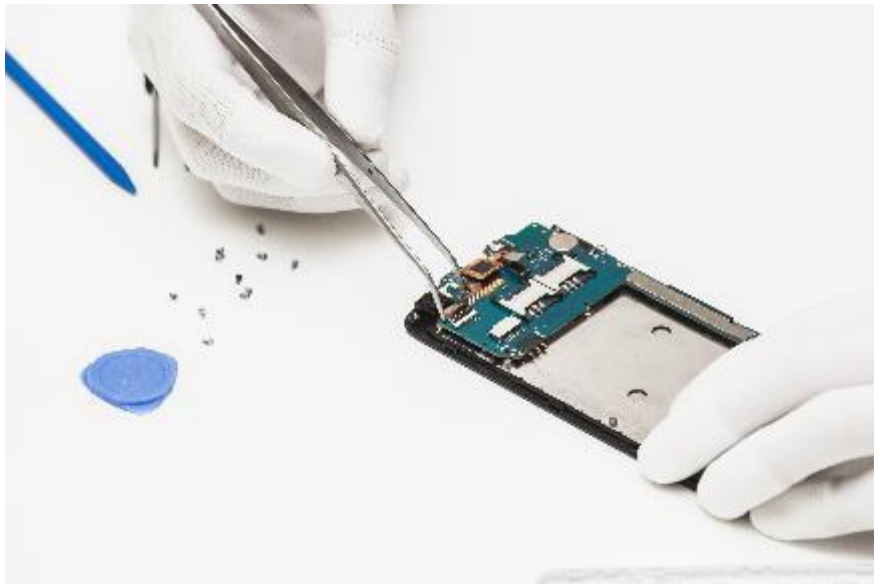


Principles

British Standard: **BS EN 61340-5-1:** Covers the requirements necessary to design, establish, implement and maintain an electrostatic discharge (ESD) control program for activities that: manufacture, process, assemble, install, package, label, service, test, inspect, transport or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 V.

All the precautions discussed within the EPA should be adhered to this standard.

Processes and policies should cover ESD precautions and monitoring of these from the goods in, through the assembly and testing, right through to either ESDS leaving or no longer being sensitive.



Frequently Asked Questions

Q: What does “earthing” myself actually do?

A: It puts you at the same voltage potential as your EPA.

Q: What if I don’t bother with “earthing” myself?

A: You may cause an ESD onto a component / PCB.

Q: If I can’t feel it, is it still a problem?

A: YES! We start to feel it from 3000v, hear it from 2000v and see it from 5000v. Considering that there are components around with thresholds of less than 50v, we are better off being rather safe than sorry.

Q: Is a damaged component scrap?

A: If the component has “catastrophic” damage, it will show up in test, BUT “latent” damage may not appear as a failure until later; i.e. tomorrow, next week, next month, maybe next year… nobody knows!

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Any Questions?

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