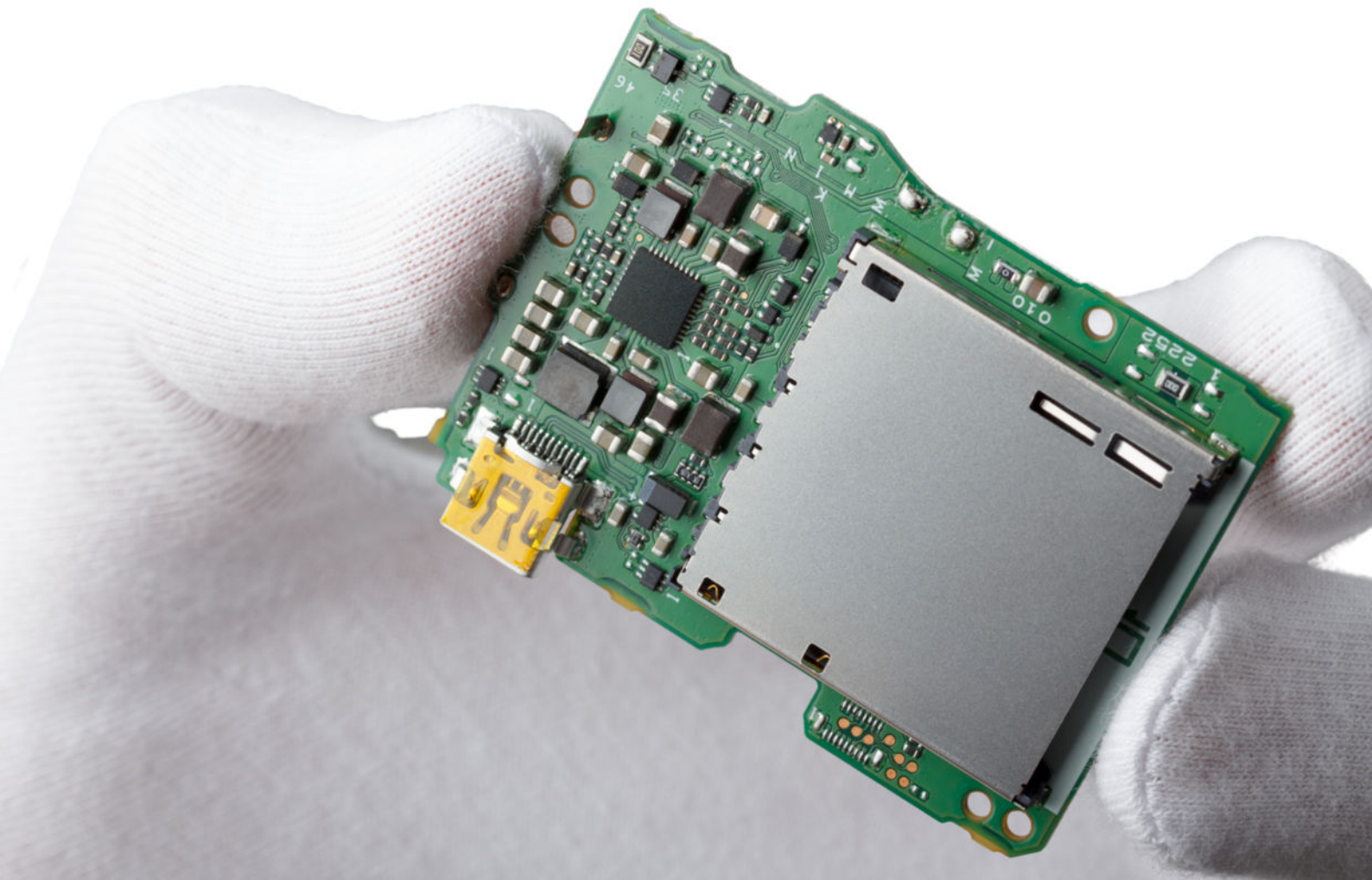


**BONDLINE**

# A Guide to Electrostatic Discharge (ESD)



## **ESD Terminology Glossary**

### **Antistatic**

The term “antistatic” is a minimal generation or retention of a static charge. It usually refers to the property of a material that inhibits triboelectric charging.

### **Conductive**

The term “conductive” refers to the ability of a material to conduct a charge to ground; low resistance (i.e. less than 1 meg-ohm ( $10^6$ )) – the closer to 1 meg-ohm, the slower the discharge.)

### **ESD**

The term “ESD” is the abbreviation for electrostatic discharge. Electrostatic discharge (ESD) is an uncontrolled surge of static between objects with different voltage potentials.

### **EPA**

The term “EPA” is the abbreviation for Electrostatic Protected Area. An EPA is a static-safe handling area where static-sensitive electronic components and devices are handled, requiring special ESD protection.

### **Faraday Cage**

A “Faraday Cage” is a conductive barrier against ESD that attenuates a stationary electric field e.g. Metallised Shielding Bag, Conductive Box, etc.

### **Insulative**

An insulator does not allow the free flow of electrons, therefore it will more than likely cause problems to prevent a path to Earth, hold a static field, etc. Examples of insulative materials include: plastic, glass, wood and rubber.

### **Potential difference**

Potential difference causes ESD when there is a static voltage difference between two items/objects: i.e. flooring, articles of clothing, shelving, etc.

### **Tribocharge**

Tribocharge is the generation of electrostatic charges by the rubbing or separating of surfaces.

# **The Basics of ESD**

## **What is Static Electricity?**

Static electricity is a fixed electric charge, typically produced by friction, which causes sparks, crackling or the attraction of dust or hair.

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

In normal conditions, there are the same amount of protons and electrons, giving atoms no control. However, these electrons can move. When separating or rubbing together, 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. (Dependent on the movement and direction of electrons). If the material in question is an insulator, this charge can be held and not moved - this is called static electricity.

## **What is Electrostatic Discharge (ESD)?**

Electrostatic discharge can occur when two surfaces come into contact and create friction with each other. Examples include: walking over synthetic floors, rubbing of synthetic garments, shifting of plastic boxes, unrolling of PVC adhesive tape and the movement of a conveyor belt. When two surfaces come into contact with each other, this can build up an electrostatic charge. One surface becomes positively charged and the other surface becomes negatively charged causing an imbalance.

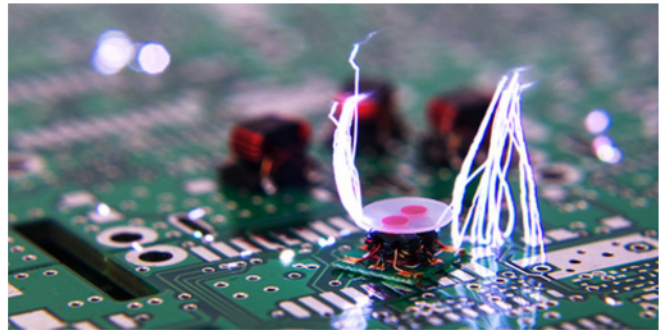
The amount of static electricity generated depends on the materials subjected to contact or separation, friction, the area of contact or break, and the relative humidity of the environment. At lower relative humidity, as the climate is drier, charge generation will increase significantly. If the electrostatic charge comes into contact with the suitable material, it transfers and causes an ESD event. ESD can also occur when a high electric field develops between two objects nearby.

In a typical environment like your home, numerous ESD events can occur, most of which you do not see or feel. It takes a discharge of about 2,000 volts for a person to feel an electric "zap". Although, with events like lightning, it requires a much larger ESD event to arc and be seen.

While a discharge may be a nuisance in the home, ESD is a significant problem in a high tech manufacturing environment and should be avoided at all costs. The modern electronic circuitry we see on components such as printed circuit boards, can be burnt or melted from these miniature lightning bolts of 'ESD' and cause irreversible damage to them. ESD has cost the electronics manufacturing industry millions, if not, billions of pounds worth of damage and replacements. ESD control is, therefore, necessary to reduce and limit these ESD events.

### ESD can result in:

- Failures;
- Higher costs;
- Lower quality products;
- Reduced reliability;
- Reduced customer satisfaction.



### Typical Electrostatic Voltages

#### **Walking across a carpet**

1,500 – 35,000 volts

#### **Operator at a bench**

100 – 6,000 volts

#### **Walking over an untreated vinyl floor**

250 – 12,000 volts

#### **Chair with urethane foam**

1,500 – 18,000 volts

#### **Unwinding regular tape**

9,000 – 15,000 volts

#### **Picking up a standard plastic bag from a bench**

1,200 – 20,000 volts

### Did you know?

Voltages as little as 10 volts can damage a component, 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.

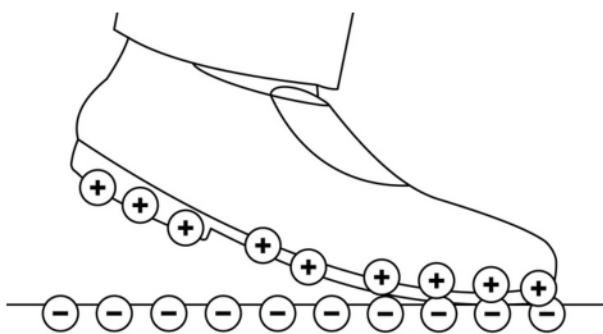
*People generate charge frequently but for a person to feel a discharge it must be around 3,000 volts. (Source: ESD Association).*

## Common Sources of ESD Damage

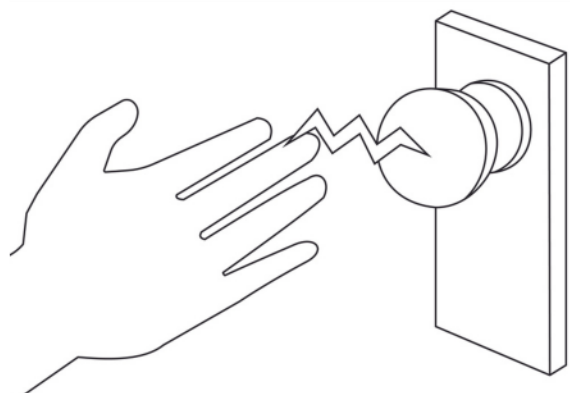
The typical work environment has many different sources of static electricity. It's important to learn about these different sources so that you can avoid them or put effective countermeasures in place to keep your static sensitive electronic components and devices protected from ESD.

**Here are some examples of where static charges can come from:**

- A typical scotch tape dispenser: the tape itself builds a static charge coming off the roll and dispenser.
- Placing static sensitive components on work surfaces that are not ESD safe.
- Waxed surfaces or those made from plastic.
- Waxed floors, vinyl tiled floors.
- Using plastic bags for storing electronic components / devices.
- Using packaging materials that have lost their anti-static properties over time.
- Typical office supplies made of insulating materials.
- Plastic water bottles on the workstation.
- Wearing ordinary coats or smocks and footwear.



**Walking across a carpeted floor creates a build up of electrostatic charge on the person.**




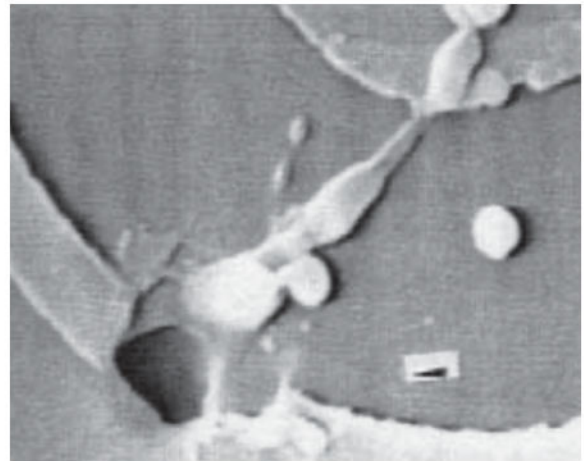
**Static discharges when contact is made with door handle, causing the person to feel a "shock".**

## Types of ESD Damage

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

### Catastrophic Failure

**Total failure of circuit.** When an electronic device is exposed to an ESD event it may have caused a metal melt, junction  on 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.

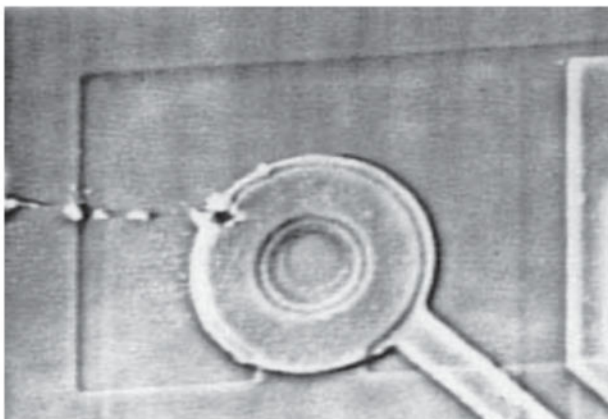


### Latent Damage

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 may be reduced dramatically. This could cause premature system failure which could prove extremely hazardous and very costly.

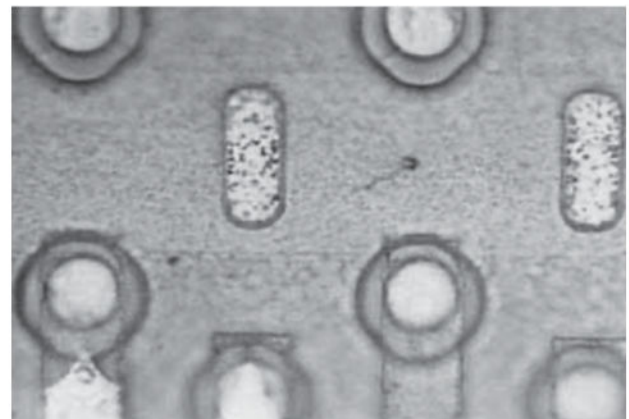
### Circuit Damage

**Damage to the component's circuit.**



### Short Circuit

**Malfunction in circuit.**



## What Causes Devices To Fail?

Damage is usually caused by one of three events:

- **Direct ESD to the device** - can occur when any charged conductor (including the human body) discharges to an item.
- **ESD from the device** - the transfer of charge from an ESD susceptible item to a conductor. For example, through handling or contact and separation from packaging materials, worksurfaces or machine surfaces.
- **Field-induced discharges** - when an object becomes electrostatically charged it creates an electrostatic field.

Whether or not damage occurs to an ESD susceptible item by an ESD event is determined by the device's ability to dissipate the energy of the discharge or withstand the voltage levels involved. The level at which a device fails is known as the device's ESD sensitivity or ESD susceptibility.

## Understanding ESD Symbols

If you've been handling static sensitive devices for a while, you've most likely come across the various ESD symbols already. But do you know the difference(s) and when to use them? If you are new to ESD protection or have just taken over responsibility for an existing ESD program, keep reading below!



### ESD Susceptibility Symbol

The ESD Susceptibility Symbol is the most commonly known symbol which consists of a yellow hand in the act of reaching, deleted by a bar; all within a black triangle. It is intended to identify devices and assemblies that are susceptible to ESD.



### ESD Protective Symbol

The ESD Protective Symbol has a reaching hand in a triangle. However, note the arc and missing slash through the triangle! Because of these differences it has a very different meaning. This symbol should be on ESD protective products identifying a specialty product that has at least one ESD control property.

## How Can You Prevent ESD?

To protect your static sensitive electronic components and devices from static damage, you should look to equip your work area with proper static control items:



### ESD Bench / Floor Matting

ESD mats dissipate static charge through the mat's top (dissipative) layer, travelling through the conductive under layer, and then the stud to Earth. Both bench and floor ESD matting is required to be connected to ground.



### ESD Protective Bags

Electronic components and devices must be placed in ESD protective bags / packaging before being moved away from the ESD Protected Area (EPA).



### Earth Bonding Points

A common ground point allows all connected items to be used at the same potential. Usually, utility ground (mains ground) is used. Earth Bonding Points come in a variety of types including plugs and brackets.



### ESD Flooring

ESD flooring prevents the build-up of static electricity as people walk across the floor by grounding the static charge to Earth. It is the cornerstone to any ESD control program.



### ESD Wrist Straps and Cords

ESD wrist straps and cords carry the static charge away from the person and discharge the static safely to ground. People that sit at a bench should always wear an ESD wrist strap and cord, even if they wear foot grounders.



### ESD Garments and Gloves

ESD garments and gloves are an important element of an EPA. They help prevent static charges from damaging static sensitive electronic components. They are woven with conductive fibres that provide a 'Faraday Cage' effect.



### ESD Testing Instruments

ESD wrist strap and footwear testers are used to check the continuity of the grounding equipment. They ensure contact is made with the user ensuring they function correctly before entering the EPA. Surface resistance meters are used to test the resistance of surfaces used in the EPA.



### ESD Workbenches

ESD workbenches are an integral part of an EPA. An ESD workbench provides you with an area where you can safely work with static sensitive electronic components and devices.



### ESD Shoes and Heel Straps

ESD shoes and heel straps work similarly. They only pass the static charge through an Earthed ESD floor where the static charge will be grounded. Foot grounders allow personnel that stand or move on the job, to equalise static potential to ground.



### ESD Warning Signs and Labels

ESD warning signs keep everyone mindful of the correct handling requirements, and define an ESD protected area. ESD labels help to identify static sensitive contents placed inside of ESD bags, boxes, bins, etc.

Visit [www.bondline.co.uk](http://www.bondline.co.uk) to discover our full ESD control product range.