



Quality Procedures Manual

Static Sensitive Devices

1. POLICY.

FDE is committed to proper handling and care of electrostatic sensitive components and devices. This commitment is demonstrated in providing appropriate equipment, supplies, facilities, and training to safeguard customer and company assets.

2. RESPONSIBILITY.

The Quality Assurance Manger is responsible for establishing and monitoring the company Electrostatic Discharge (ESD) Protection Program. Management will support this program by providing resources necessary to implement the outlined policies and procedures.

3. DEFINITIONS.

Electrostatic Discharge (ESD) The rapid discharge of static electricity from one conductor to another of a different potential. An electrostatic discharge can damage components found in computers, communications, or any other type of electronic equipment.

ESD Wrist Strap A safety device used to channel static electricity to a proper ground while handling sensitive components and equipment. ESD damage occurs when a release of stored static electricity travels from something such as a person's body into a conductor of a different potential, such as a computer being repaired. The ESD wrist strap safely channels the static electricity to a proper ground.

4. IMPLEMENTATION.

A. The ESD Protection Program will concentrate on the following four areas:

- 1) **Design In Immunity** - Engineering reviews will be conducted to assure that products and assemblies have been designed to be reasonably immune from the effects of ESD.
- 2) **Eliminate and Reduce Generation** – The Quality Assurance Department will conduct initial and refresher training on procedures for reducing and eliminating static-generating processes, keeping processes and materials at the same electrostatic potential, and providing appropriate ground paths to reduce charge generation and accumulation.
- 3) **Dissipate and Neutralize** - Management will provide assets to prevent ESD by grounding, ionization, and the use of conductive and dissipative static control materials.
- 4) **Protect Products from ESD** – The Shipping and Receiving Departments will insure proper grounding or shunting, and the use of static control packaging and materials handling products.

B. Policies

- 1) All static sensitive devices, components, or assemblies are to be handled ONLY at Static-Safe work stations and transported in their original static protective container or an approved static protective tote box. The container should form a Faraday Cage such that any static charge built-up on the container should stay on the outside and not damage the contents. An open conductive box or bag will NOT give



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sufficient protection. The following are some of the approved types of static protective material that may be used:

- Approved static shielding bags
 - Conductive tote boxes/storage bins
 - Conductive black foam
 - Conductive Dual In-Line Package (DIP)
 - LWO-Pink-Poly Wrap, Used with other approved conductive material
- 2) Static sensitive work stations will include at a minimum a wrist strap and conductive table top or mat which is connected to earth ground through a limiting resistance of 10-100 Megohms.
 - 3) All personnel handling ESD sensitive devices, components, or assemblies MUST be grounded with a wrist strap. The wrist strap MUST be attached directly to ground. A wrist strap keeps a person at ground potential by preventing a net accumulation of static charge. As a personnel safety feature, wrist straps should contain a 1 Megohm resistor to limit current should a live circuit come in contact with the work surface or worker.
 - 4) **WARNING: All chassis grounded equipment must be kept off of the work surface or the safety resistor will be defeated! A 1 meg ohm resistor must be in series with any wrist strap lead attached to an instrument chassis.**
 - 5) Static sensitive work stations shall be kept clean and clear of any accumulation of non-related M&TE such as paper, rags, carpet, gloves, and other items that could carry a static charge and/or insulate parts and containers from the grounded work surface.
 - 6) In the event counting is required, parts shall not be removed from vendor packaging. If packaging is not transparent, counting shall not be performed.
 - 7) When ESD sensitive devices must be removed from their storage bag/container to fill a requisition, containers will be taken to a static safe work station and the following procedures utilized:
 - 8) Before touching parts, remove personal static by attaching the static station grounded wrist strap to wrist. Maintain this static discharge path while removing the required device, component, or PCB assembly from the storage container onto a static conductive tray, mat, or foam.
 - 9) Insert the device leads into conductive foam, or short all contacts together using a static conductive shunt bar or foam strip.
 - 10) Place the ESD sensitive parts in a static protective bag and make sure it displays an ESD Sensitivity WARNING Label, as shown in Figure No. 1.
 - 11) To transport static sensitive parts directly to another static safe location, a static conductive tray or tote box may be substituted for the static protective bag.



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C. Discussion and Guidelines

Personnel and Moving Equipment

In many facilities, people are one of the prime generators of static electricity. The simple act of walking around or repairing a board can generate several thousand volts on the human body. If not properly controlled, this static charge can easily discharge into a static-sensitive device—a human body model (HBM) discharge.

Even in highly automated assembly and test processes, people still handle static-sensitive devices ... in the warehouse, in repair, in the lab, in transport. For this reason, static control programs place considerable emphasis on controlling personnel-generated electrostatic discharge. Similarly, the movement of carts and other wheeled equipment through the facility can also generate static charges that can transfer to the products being transported on this equipment.

Wrist Straps

Typically, the primary means of controlling static charge on personnel is with a wrist strap. When properly worn and connected to ground, a wrist strap keeps the person wearing it near ground potential. Because the person and other grounded objects in the work area are at or near the same potential, there can be no hazardous discharge between them. In addition, static charges are safely dissipated from the person to ground and do not accumulate.

Wrist straps have two major components, the cuff that goes around the person's wrist and the ground cord that connects the cuff to the common point ground. Most wrist straps have a current-limiting resistor molded into the ground cord head on the end that connects to the cuff. The resistor most commonly used is a one megohm, 1/4 watt with a working voltage rating of 250 V.

Wrist straps should be tested on a regular basis. Daily testing or continuous monitoring is recommended.

Floors, Floor Mats, Floor Finishes

A second method of controlling electrostatic charge on personnel is with the use of ESD-protective floors in conjunction with ESD-control footwear or foot straps. The combination of floor materials and footwear provides a ground path for the dissipation of electrostatic charge, thus reducing the charge accumulation on personnel and other objects to safe levels. In addition to dissipating charge, some floor materials (and floor finishes) also reduce triboelectric charging. The use of floor materials is especially appropriate in those areas where increased personnel mobility is necessary. In addition, floor materials can minimize charge accumulation on chairs, carts, walking stackers, lift trucks, and other objects that move across the floor. However, those items require dissipative or conductive casters or wheels to make electrical contact with the floor.

Shoes, Grounders, Casters

Used in combination with ESD-protective floor materials, static control shoes, grounders, casters, and wheels provide the necessary electrical contact between the person or object and the floor material. Insulative footwear, casters, or wheels prevent static charges from flowing from the body to the floor to ground.

Clothing

Clothing is a consideration in some ESD-protective areas, especially in cleanrooms and very dry environments. Clothing materials can generate electrostatic charges when they contact and separate from other objects and the clothing itself. These charges may discharge into sensitive components or create electrostatic fields that may induce



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charges on the human body. Although a person may be grounded, that does not mean that insulative clothing fabrics can dissipate a charge to that person's skin and then to ground. Clothing usually is electrically insulated or isolated from the body. Static control garments are intended to minimize the effects of electrostatic fields or charges that may be present on a person's clothing.

Workstations and work surfaces

Work surfaces and workstations are important parts of an ESD-protective program. Many ESD-sensitive devices and assemblies are handled, assembled, or repaired at workstations.

An ESD-protective workstation refers to a single individual's work area that is constructed and equipped with materials and equipment to limit damage to ESD-sensitive items. It may be a stand-alone station in a stockroom, warehouse, or assembly area, or in a field location such as a computer room.

The workstation provides a means for connecting all work surfaces, fixtures, handling equipment, and grounding devices to a common point ground. In addition, there may be provision for connecting additional personal grounding devices, equipment, and accessories such as constant ground monitors and ionizers. The key ESD control elements comprising most workstations are a static-dissipative work surface, a means of grounding personnel (usually a wrist strap), a common grounding connection, and appropriate signage and labeling.

Static-protective work surfaces with a resistance to ground of 10^6 to 10^9 ohms provide a surface that is at the same electrical potential as other ESD-protective items in the workstation. They also provide an electrical path to ground for the controlled dissipation of any static potential on materials that contact the surface. The work surface also helps define a specific work area in which ESD-sensitive devices may be safely handled. The work surface is connected to the common point ground.

Production Equipment and Production Aids

Although personnel-generated static is typically the primary ESD culprit in many environments, automated manufacturing and test equipment can also pose an ESD problem. For example, a device may become charged from sliding down the feeder. If the device then contacts the insertion head or another conductive surface, a rapid discharge occurs from the device to the metal object—a charged device model (CDM) event.

In addition, various production aids may also pose an ESD problem. Production aids are those materials, tools, and fixtures that help to produce finished products but do not become part of the finished product. Some examples are hand tools, soldering irons, tapes, solvents, and so forth.

Grounding is the primary means of controlling static charge on many production aids and equipment. The metal chassis or conductive enclosure of equipment that uses utility power is required by the National Electrical Code to be connected to the equipment ground (the green wire) in order to carry fault currents. This ground connection will also function for ESD purposes. All electrical tools and equipment used to process ESD-sensitive hardware require the three-prong grounded type ac plug. Hand tools that are not electrically powered, i.e., pliers, wire cutters, and tweezers, are usually grounded through the ESD work surface and the (grounded) person using the conductive tools. Holding fixtures should be made of conductive or static-dissipative materials when possible. If a conductive fixture is not sitting on an ESD work surface or handled by a grounded person, a separate ground wire may be required. For those items that are composed of insulative materials, the use of ionization or application of topical antistats may be required to control generation and accumulation of static charges.

Packaging and Materials Handling



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Direct protection of ESD sensitive devices from electrostatic discharge is provided by packaging materials such as bags and corrugated, rigid, or semirigid packages. The primary use of these items is to protect the product when it leaves the facility, usually when shipped to a customer. In addition, materials-handling products such as tote boxes and other containers primarily provide protection during inter- or intrafacility transport.

The main ESD function of these packaging and materials-handling products is to limit the possible impact of ESD from triboelectric charge generation, direct discharge, and electrostatic fields. The initial consideration is to have low-charging materials (antistatic) in contact with ESD-sensitive items. For example, the antistatic property would control triboelectric charge resulting from sliding a board or component into the package or container. A second requirement is that the material provide protection from direct electrostatic discharge as well as shield from electrostatic fields.

Many materials are available that provide all three benefits: antistatic, discharge protection, and electric field suppression. The inside of these packaging materials has an antistatic layer, but also has an outer layer with a surface resistance generally in the dissipative range.

A material's antistatic properties are not necessarily predicted by its resistance or resistivity. However, resistance or resistivity measurements help define the material's ability to provide electrostatic shielding or charge dissipation. Electrostatic shielding attenuates electrostatic fields on the surface of a package in order to prevent a difference in electrical potential from existing inside the package. Electrostatic shielding is provided by materials that have a surface resistance equal to or less than 1.0×10^3 ohms when tested according to EOS/ESD-S11.11 or a volume resistivity of equal to or less than 1.0×10^3 ohm/cm when tested according to the methods of EIA 541.

Dissipative materials provide charge dissipation characteristics. These materials have a surface resistance greater than 1.0×10^4 but less than or equal to 1.0×10^{11} when tested according to EOS/ESD-S11.11 or a volume resistivity greater than 1.0×10^5 ohm/cm but less than or equal to 1.0×10^{12} ohm/cm when tested according to the methods of EIA 541. Be aware that the very wide range of resistance and resistivity results in a wide range of performance.

Grounding

Effective ESD grounds are of critical importance in any operation, and ESD grounding should be clearly defined and regularly evaluated.

ESD Association standard ANSI EOS/ESD 6.1—Grounding recommends a two-step procedure for grounding ESD-protective equipment.

The first step is to ground all components of the work area (work surfaces, people, equipment, etc.) to the same electrical ground point called the *common point ground*. This common point ground is defined as a "system or method for connecting two or more grounding conductors to the same electrical potential."

This ESD common point ground should be properly identified. ESD Association standard EOS/ESD S8.1-1993 recommends the use of a symbol to identify the common point ground.

The second step is to connect the common point ground to the equipment ground or the third (green) wire electrical ground connection. This is the preferred ground connection because all electrical equipment at the workstation is already connected to this ground. Connecting the ESD control materials or equipment to the equipment ground brings all components of the workstation to the same electrical potential. If a soldering iron used to repair an ESD sensitive item were connected to the electrical ground and the surface containing the ESD sensitive item were connected to an auxiliary ground, a difference in electrical potential could exist between the iron and the ESD sensitive item. This difference in potential could cause damage to the item.



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Any auxiliary grounds (water pipe, building frame, ground stake) present and used at the workstation must be bonded to the equipment ground to minimize differences in potential between the two grounds.

Ionization

As previously explained, the primary method of static charge control is direct connection to ground for conductors, static-dissipative materials, and personnel. However, a complete static control program must also deal with isolated conductors that cannot be grounded and insulating materials (e.g., most common plastics). Topical antistats are often used to dissipate static charges from these items under some circumstances.

More frequently, however, air ionization can neutralize the static charge on insulated and isolated objects by charging the molecules of the surrounding air. Whatever static charge is present on objects in the work environment will be neutralized by attracting opposite polarity charges from the air.

Air ionization is not a replacement for grounding methods. It is one component of a complete static control program. Ionizers are used when it is not possible to properly ground everything and as backup to other static control methods.

Identification

A crucial element in the static control program is the use of appropriate symbols to identify static-sensitive devices and assemblies, as well as products intended to control ESD. The traditional symbols used to identify ESDS parts or ESD control materials have been replaced with newer, more appropriate symbols. ESD Association standard ANSI ESD S8.1-1993—ESD Awareness Symbols provides two symbols for ESD identification.

The ESD Susceptibility Symbol consists of a triangle, a reaching hand, and a slash through the reaching hand. The triangle means "caution" and the slash through the reaching hand means "Don't touch." Because of its broad usage, the hand in the triangle has become associated with ESD, and the symbol literally translates to "ESD-sensitive stuff, don't touch."

The ESD Susceptibility Symbol is applied directly to integrated circuits, boards, and assemblies that are static-sensitive. It indicates that handling or use of this item may result in damage from ESD if proper precautions are not taken. If desired, the sensitivity level of the item may be added to the label.

The ESD Protective Symbol consists of the reaching hand in the triangle. An arc around the triangle replaces the slash. This "umbrella" means protection. The symbol indicates ESD-protective material. It is applied to mats, chairs, wrist straps, garments, packaging, and other items that provide ESD protection. It may also be used on equipment such as hand tools, conveyor belts, or automated handlers that are especially designed or modified to provide ESD control.

Neither symbol is applied on ESD test equipment, footwear checkers, wrist strap testers, resistance or resistivity meters, or similar items that are used for ESD purposes, but which do not provide actual protection.



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The **ESD susceptibility symbol** incorporates a "reaching hand" in a triangle with a slash through it to indicate that the item so marked is susceptible to ESD damage and should not be touched without ESD safe handling tools.



The **ESD protective symbol** differs from the ESD susceptibility symbol, by the addition of an arc around the outside of the triangle and the omission of the slash across the hand and the triangle. It should be used to identify items that are specifically designed to provide ESD protection, such as for instance packaging. Instead of the asterisk a letter indicates the primary function of the packaging material :

S=Electrostatic Discharge Shielding
D=Electrostatic Dissipative
L=Low Charging
C=Electrostatic Conductive

Figure 1: ESD Symbols

General guidelines for working on PCs in an office environment

- Avoid carpets in cool, dry areas. Leave PC cards and memory modules in their anti-static packaging until ready to be installed.
- Dissipate static electricity before handling any system components (PC cards, memory modules) by touching a grounded metal object, such as the system unit unpainted metal chassis.
- If possible, use antistatic devices, such as wrist straps and floor mats.
- Always hold a PC card or memory module by its edges. Avoid touching the contacts and components on the memory module.
- Take care when connecting or disconnecting cables. A damaged cable can cause a short in the electrical circuit.
- Prevent damage to the connectors by aligning connector pins before you connect the cable. Misaligned connector pins can cause damage to system components at power-on.
- When disconnecting a cable, always pull on the cable connector or strain-relief loop, not on the cable itself.



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5. REFERENCES.

[Electrostatic Discharge Association: Fundamentals of ESD](#)

ESD-S1.1—Evaluation, Acceptance, and Functional Testing of Wrist Straps

ANSI EOS/ESD S3.1—Ionization

ESD STM 4.1 (Revised)—ESD Protective Work Surfaces—Resistive Characterization

ANSI EOS/ESD S6.1—Grounding—Recommended Practice

ANSI ESD S7.1—Floor Materials—Resistive Characterization of Materials

ANSI ESD S8.1—ESD Awareness Symbols

ESD S9.1—Resistive Characterization of Footwear

ANSI ESD S11.1—Surface Resistance Measurement of Static Dissipative Planar Materials

ANSI ESD S11.31—Evaluating the Performance of Electrostatic Discharge Shielding Bags

ESD STM2.1—Garments

ESD SP 3.3—Periodic Verification of Air Ionizers

ESD ADV53.1—ESD Protective Workstations

ESD ADV2.0—*ESD Handbook*

EIA-541—Packaging of Electronic Products for Shipment