Methods of Personnel Grounding

What to Use and Why It's Needed

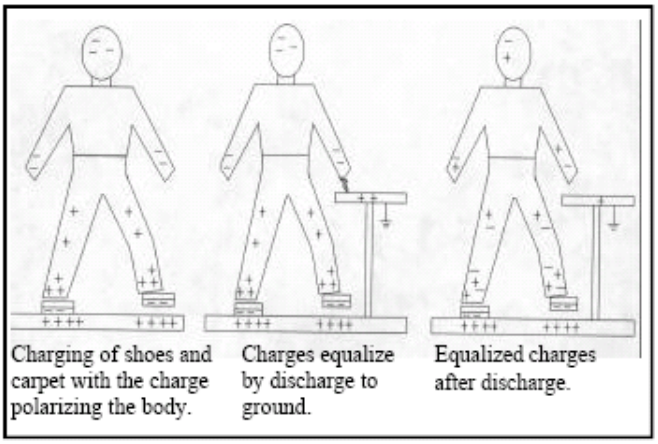
Our thanks to 3M for allowing us to reprint the following.

Background

Personnel grounding is a corner stone of safeguarding static sensitive electronic devices in production areas. People are one of the greatest sources of static electricity. As we move about, we continually touch and move away from things around us. This contact and separation with objects leaves charge on us and the objects. Static charge generated by contact and separation is called Tribocharging. A good example of tribocharging involves walking across carpet. (See figure 1) As we walk, our shoes contact and separate from the flooring or carpet. Charge effectively accumulates on our bodies. When you touch a grounded object or an object with a different charge level, like a door knob, electrostatic discharge (ESD) occurs.

By grounding people, their static charges are recombined with opposite charges from the earth as the charges on people are generated. This avoids ESD and protects sensitive electronic devices.

FIGURE 1. TRIBOCHARGING EXAMPLE.

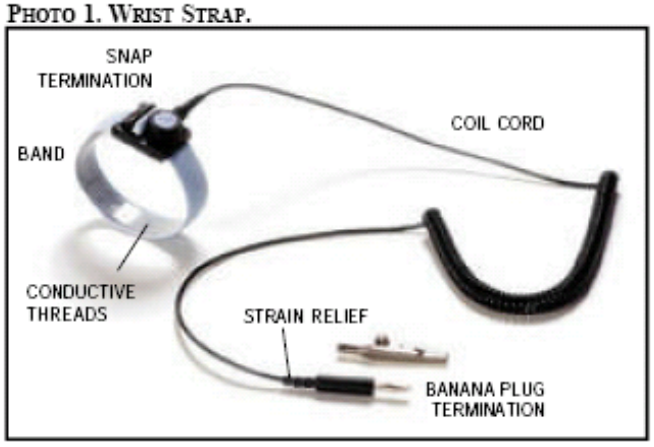


Grounding Methods

Wrist Straps

A wrist strap consists of a conductive cuff (also call a band) and a wire that connects a person to ground (See photo 1). This wire is usually coiled and called a coil cord. The wire expands as the person moves away from the ground connection, and retracts as the person approaches the ground connection. Expanding and retracting keeps the wire from interfering with the wearer's work.

PHOTO 1. WRIST STRAP.



Basic functionally and performance is defined in ESD Association's EOS/ESD Standard 1. Key requirements include a 1 megohm or other value resistor in the electrical path from the person to ground. This resistor is included to limit current flow through the user should the user inadvertently contact electricity.

Exterior of the band and the cord must be insulative to prevent inadvertent ground contact with exposed electrical sources. Finally, the strain reliefs where the coiled cord terminates to connectors must survive 16,000 bending cycles.

Many different product configurations allow wrist straps to meet S1 requirements. The most common band is made from elastic and nylon with metal thread or fibers woven into the skin contact side of the band. A stamped metal plate captures the fabric on one end and improves skin contact. Buckles of various designs allow the other end of the fabric to be adjusted. Metal "Spiedel" style bands are also used. These bands are very durable and provide good electrical connection to the skin.

Coil cords are made from plastic coated tensile wire. Terminations are molded onto the wire. Terminations include several kinds of snaps for the band connection and usually a banana plug for ground connection.

Foot Grounding

Shoe Grounders

Used with a grounded, static dissipative floor mat or floor covering, Heel and Toe Grounders are designed to be worn on the shoe. (See photos 2 and 3) A conductive

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ribbon placed inside the sock or inside the shoe under the heel, connects the wearer to the conductive sole of the grounder. Usually a 1 megohm resistor is placed in the path. The ESD Association is currently developing a standard for shoe grounders.

Designs for grounders vary substantially. Most use hook and loop (Velcro) material to provide a secure fit and adjustability. Buckles are used for adjustment on heel grounders. Sole material is usually conductive on the floor contact side and insulative on the shoe contact side, and is designed not to mark the shoe.

Grounders must be worn on both feet so that a walking person is continuously grounded.

Footwear

Specially constructed shoes can be used with a grounded, static dissipative floor mat or floor covering. These shoes have a conductive sole or patch on the sole connected to a contact in the insole. The insole contacts the person's socks. Sweat in the shoe provides the moisture to make the connection.

Grounders versus Footwear

Both products offer advantages. Grounders are inexpensive and require little maintenance. However, grounders must be put on and taken off each shift. Shoes do not require policing by supervisors to ensure their use. However, they are expensive, and must be cleaned. Both shoes and grounders should be tested on the wearer for proper conductivity.

PHOTO 2. HEEL GROUNDER

Miscellaneous Grounding

Garments

Some lab coats and smocks have a cuff or wrist band built into them. A coil cord snaps to the garment. The garment must be specially constructed in a way that provides a continuous electrical path from the snap point to the body contact point. Care should be exercised that the grounding cuff or band is not placed over clothing. Policing proper technique can be difficult.

Body Grounders

A metal clip or strip of conductive fabric is attached to a person's waist, with the metal or cloth placed inside their pants. The coiled cord is then snapped to the clip. Hands

PHOTO 3. TOE GROUNDER

are freed for production. Difficulty arises from the desire to wear smocks, personnel that wear garments other than pants. Also, insuring proper technique for placing the body clip on a person can be time consuming.

Application

Wrist Straps are the primary defense against static damage. Everyone handling or residing within two feet of unpackaged sensitive devices should be wearing a grounded wrist strap. (Here, packaging refers to static shielding containers)

For personnel that stand or walk, foot grounding is a good option. However, seated personnel should be encouraged to use a wrist strap even when using foot grounding. Many people lift their feet from the floor while seated, breaking the ground connection.

Body grounders and grounded garments have application in some specialized situations, but usually demand a premium in cost and policing.

Techniques That Do Not Work

Ionization

Ionizers neutralize charge by supplying an air stream with equal amounts of positive and negative charges. These charges recombine with opposite charges on objects.

While useful for neutralization, static charge on slow moving or stationary objects, ionizers are not effective for removing charge from people. It can take 20 or 30 seconds to neutralize charge on an object held in the airstream of an ionizer. Voltage on people accumulates too quickly for an ionizer to neutralize.

Touching a Mat

Trying to avoid the use of wrist straps or grounders by instructing personnel to touch a grounded mat before handling sensitive product will very likely lead to damaged devices. After touching a mat to ground themselves, people continue to move and generate

charge. A continuous connection to ground is required to protect devices.

Floor Mats without Grounders

Grounders make an electrical connection from the person to the mat. Without grounders, a person's shoes insulate them from the mat. While a grounded floor mat will suppress the field surrounding a charged person, the person retains charge which can damage devices. A continuous ground connection via wrist strap or grounders and mat is mandatory.

"Cordless" Wrist Strap

As ridiculous as this may sound, an Asian manufacturer is supplying a wrist band with no ground cord, claiming that it will dissipate charge from people. They place steal wool inside a plastic case on the wrist band in an attempt to improve static decay of the human body through ionization. Of course, the product does not work well enough to replace a connection to earth ground. However, the claims made by the brochure can be quite amusing.

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a. If a material is conductive, then ground it.

b. If a material is insulative, remove it from the production area or make it conductive and ground it.

c. If it cannot be made conductive or removed, then shield it. (or consider ionization)

d. Control the charge on people because people are the most common source of charge and ESD.

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