

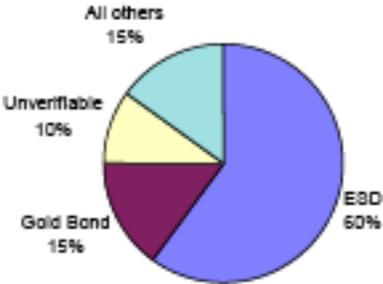
# Static Control Measures

ESD Control Handbook

*Why Should I Care About Electrostatic Discharge?*

**Static Control Measures for Handling Electronic Parts**

Electrostatic discharge (ESD) costs the electronics industry millions of dollars annually in damaged and degraded parts. A study in Semiconductor Reliability News estimated that approximately 60% of device failures are EOS/ESD caused.



Source: Semiconductor Reliability News, March 1993



*What Is ESD*

The contact and separation of materials creates a static charge. An example of a common electrostatic event occurs when a charged individual discharges to a doorknob.



The contact and separation of feet when walking across a floor creates a charge on the individual. The discharge to the doorknob is an example of an Electrostatic Discharge (ESD). The simple act of walking across a floor can generate 15,000 volts of static electricity.

*Human Awareness Levels*

- We feel the discharge if it is greater than 3,500 volts.
- We hear the discharge if it is greater than 5,000 volts.
- We see the discharge if it is greater than 8,000 volts.
- By comparison, integrated circuits that are used to make electronic circuit boards can be damaged by voltages as low as 100 to 1,000 volts.

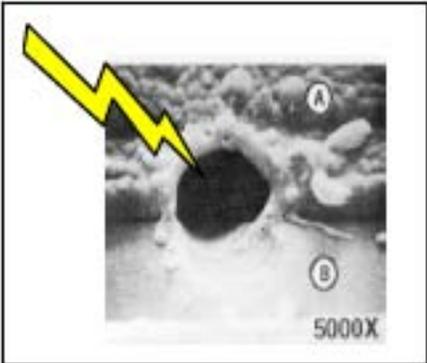
*Typical Electrostatic Voltages*

Event	Voltages at Relative Humidity		
	10%	40%	55%
Walking Across Carpet	35,000	15,000	7,500
Walking Across Vinyl Floor	12,000	5,000	3,000
Motions of Individuals Not Grounded	6,000	800	400
Remove Bubble Pack from Package	26,000	20,000	7,000

*What is Device Sensitivity?*

Once a charge is generated, a charge can be transferred from one object onto another. This is called charge transfer. The damage is a result of energy shifting from one charged object to another object.

Static sensitive devices are subject to damage or degradation from Electrostatic Discharge (ESD). Damage occurs because small traces and materials cannot withstand the amount of energy surge introduced by an electrostatic discharge. Damage and degradation can also result from an electrostatic field.



*What is Device Sensitivity?*

**Device Sensitivity Threshold Levels**

*Device sensitivity threshold levels are well below a person's ability to detect.*

<b>Device Type</b>	<b>Threshold Susceptivity (Volts)</b>
MOSFET	10-100
VMOS	30-1800
NMOS	60-100
GaAsFET	60-2000
EPROM	100+
CMOS	200-3000
JFET	140-7000
SAW	150-500
Op-AMP	190-2500
Schottky Diodes	300-2500
Film Resistors	300-3000
Bipolar Resistors	300-7000
ECL	500+
SCR	500-1000
Schottky TTL	500-2500

*Where Do You Need Static Protection?*

- Incoming inspection and test
- Stores and storage
- Transfer carts
- Kitting
- Manual and automated insertion
- Wave soldering
- Equipment assembly and test
- Packaging and shipping
- Repair stations

*What Can I Do?*

**AT THE WORKSTATION**

Static-free workstation includes:

1. Static Control Surface
2. Floor Mat
3. Wrist Strap and/or Continuous Monitor System
4. Ionized Air (if needed)

3M™ Workstation Monitor 724 with wrist band, 5 foot coiled cord and 3M™ Monitor Stand-by Jack 3057



3M™ Wrist Strap Monitor 725 , battery operated



*Maintenance of Work Surfaces*

Use 3M™ Static Control Surface Mark Remover 8001 as required to clean work surfaces



*Solutions to Static Problems*

- 1. Prevention of Charge Generation
- 2. Dissipation of Charge
- 3. Neutralization of Charge
- 4. Shielding from Electrostatic Field



**Prevention of Charge Generation**

Wrist strap systems remove triboelectric charges as they are generated by the individual.

**Dissipation of Charge**

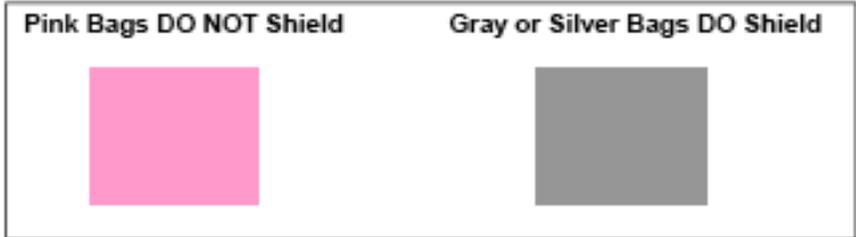
Dissipation is a slower but efficient removal of charges. An example would be a dissipative table mat or tabletop material. The material removes charge yet is resistive enough not to interfere with the “powering-up” of a circuit board in most cases.

**Neutralization of Charge**

The terminology used to describe the effect ionization will have on nonconductors. An example of a non-conductor would be a foam coffee cup. It can accumulate several thousand volts, and because the non-conductor cannot be grounded, it must be neutralized through the introduction of ionized air.

**Shielding from Electrostatic Fields**

The correct packaging used to safeguard static sensitive devices during transportation and storage must possess at least one layer of near metallic conductivity.



*3M™  
Metal-In Static  
Shielding  
Bags 1910*

## Qualifying Questions

1. What is the standard method of packaging electronic devices in your facility?
2. Do you use static shielding bags?
3. Does your company have a static shielding bag specification?
4. Do you need assistance creating a bag specification?
5. Is there a basic understanding of anti-static vs. static shielding?
6. What are your bag size requirements?
7. Are bags used as a one-time shipper or do you reuse them internally?
8. What is the estimated usage per bag size?

## Features/Advantages/Benefits

1. Metal-in, Tri-layer construction
2. Static dissipative polyethylene inner layer
3. Total thickness = 2.9 mil
4. Meets EIA-541; definition for static shielding/dissipative packaging
5. Interior is amine-free and non-corrosive
6. 3M™ Metal-In Static Shielding Bag 1910 features a zipper closure
7. Many standard sizes with custom sizes available
8. Heat sealable
9. Cost effective
10. Transparent; 40% light transmission



*3M™ Metal-Out  
Static Shielding Bag  
2100R*

**Qualifying Questions**

1. What is the standard method of packaging electronic devices in your facility?
2. Do you use static shielding bags?
3. Does your company have a static shielding bag specification?
4. Do you need assistance creating a bag specification?
5. Is there a basic understanding of anti-static vs. static shielding?
6. What are your bag size requirements?
7. Do you use bags as a one-time shipper or reuse them internally?
8. What is the estimated usage per bag size?
9. Is durability a major concern?
10. What is the minimum thickness for bags in your spec?
11. Is there a need for a bag that will provide a little extra protection (durability)?

**Features/Advantages/Benefits**

1. Polyester thickness is 92 gauge vs. 48 gauge found in low-cost static shielding bags
2. Metal-out, four-layer construction
3. Amine-free static dissipative interior
4. 3M™ Metal-Out Static Shielding Bag 2110R bags are also available with a zipper closure
5. Durability; total thickness = 3.2 mil
6. Many standard sizes with custom sizes available
7. Heat sealable
8. Functions in conditions as low as 10% relative humidity
9. Excellent tensile and puncture strength
10. Transparent; 40% light transmission
11. Meets EIA-541; definition for static shielding/dissipative packaging



## *3M™ Metal-Out Cushioned Static Shielding Bags 2120R*

### **Qualifying Questions**

1. How are your printed circuit boards packaged for shipment to the field?
2. What type of static shielding bag are you currently using?
3. Do you recycle the exterior corrugated container?
4. Does your field engineer remove printed circuit boards from the shipping container to save space in their vehicles?
5. Would a cushioned static shielding bag that provides both mechanical and static shielding protection be of value to you?

### **Features/Advantages/Benefits**

1. Durable and reusable
2. Provides excellent mechanical protection
3. Interior has no contaminating ions or amines
4. Five-layer construction
5. Open-cell construction
6. Meets EIA-541; definition for static shielding/dissipative packaging

### **Key Considerations**

1. Can replace foam package for cushioning
2. Available in roll form to be used as a wrap



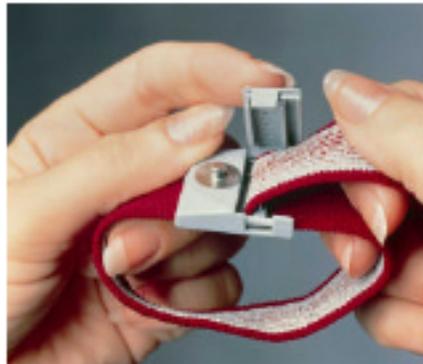
*3M™ Adjustable  
Fabric Wrist Band  
2204 with  
3M™ Wrist Strap  
Ground Cord 2210*

### **Qualifying Questions**

1. What manufacturers' band and cord are you presently using?
2. Is the band fabric or metal?
3. Do you replace them often? Why? (loss, wear out, etc.)
4. What do you like about your present band and cord?
5. How would you change the band and cord if you could?
6. Would you consider a band and cord that lasted longer and saved you money?

### **Features/Advantages/Benefits Adjustable Fabric Band**

1. Silver-plated thread completely around the inside – assures contact
2. Large stainless steel contact point
3. One size fits all
4. Hinged closure and gripping teeth secure the band in place
5. Breathable and washable
6. One year limited warranty
7. UL listed



## *3M™ Adjustable Wrist Strap 4600*

### **Qualifying Questions**

1. Do you currently use wrist straps?
2. What type: fabric, metal, other?
3. What type cord?
4. What length cord?
5. Is good electrical contact with skin a problem?

### **Features/Advantages/Benefits**

1. Lightweight
2. Low profile
3. Zipper closure mechanism
4. One size fits all
5. Low cost
6. Comfortable for long periods of time
7. 4 mm snap

### **Key Considerations**

1. The molded insulated thermoplastic band minimizes contact resistance by creating a sweat layer (natural conductor) under the band.
2. Does not need IC lotion to function properly.



## *3M™ Workstation Monitor 724*

### **Qualifying Questions**

1. How often do you test your wrist straps (once/twice a day)?
2. How do you determine a wrist strap is functional after you test?
3. Do your operators have to use IC lotion and/or adjust the band snugly to pass the test?
4. What requirements do your customers demand for testing of wrist straps?
5. How often do you test the electrical continuity of your table mat and verify ground connections?
6. What is the burdened rate of the employees testing wrist straps?
7. What is the burdened rate of the technician who verifies the functionality of your table mats?
8. What do you feel the expense of this testing costs your company annually?
9. Would a self-monitoring system for verifying wrist straps, table mats and ground connections be of interest to you?

### **Features/Advantages/Benefits**

1. Eliminates the need for any periodic testing of wrist straps, table mat electrical continuity and ground connections
2. Resistance of the operator and wrist strap is checked over 10,000 times during an eight-hour shift
3. Ground and mat connections are tested continuously
4. Reduces operating expenses
5. Payback generally recovered in less than one year
6. One monitor has the capability to monitor two operators and two workstations simultaneously. Lower cost per work station investment

### **Key Considerations**

1. Uses dual conductor cords and bands to ensure loop resistance test parameters.
2. Immediately improves the static control process to proving personnel are actually grounded.
3. Reduced static failures and improved profits.



## *3M™ Static Monitor 790*

### **Qualifying Questions**

1. How often do you test your wrist straps (once/twice a day)?
2. How do you determine how long a wrist strap is functional after test?
3. Do your operators have to use IC lotion and/or adjust the band snugly to pass a test?
4. What requirements do your customers demand for testing of wrist straps?
5. What is the burdened rate of the employees testing wrist straps?
6. What do you feel the expense of this testing costs your company annually?
7. Are you handling very sensitive electronic devices (less than 100V sensitivity)?
8. Would a self-monitoring system for verifying wrist straps and ground connections be of interest to you?

### **Features/Advantages/Benefits**

1. Eliminates the need for any periodic testing of wrist straps and ground connection
2. Voltage on the operator and wrist strap connections are continuously monitored, as well as ground connection
3. Reduces operating expenses
4. Payback generally recovered in a very short time
5. One monitor has the capability to monitor two operators continuously, which lowers your cost per workstation investment.

### **Key Considerations**

1. Uses dual conductor cords and bands to ensure test parameters (measures voltage on operator and band fit on wrist).
2. Immediately improves the static control process to proving personnel are actually grounded.
3. Reduced static failures and improved profits.



## *3M™ Wrist Strap and Footwear Tester 740*

### **Qualifying Questions**

1. How do you know your single conductor wrist strap is functioning properly?
2. What is the test voltage of your current wrist strap tester?
3. How many times a day do you test your wrist strap or shoe straps?
4. Does your present tester have the ability to determine a dry skin condition?
5. How do you know your heel grounders are working?

### **Features/Advantages/Benefits**

1. Has four upper resistance limits for both wrist straps and heel grounders
2. Is a self-contained unit that will test both wrist straps and footwear
3. Is versatile enough to meet your ESD needs today and in the future
4. Has a 20 volt open circuit test voltage for both wrist strap/heel grounder testing
5. Good wrist straps and heel grounders are kept in use and not disposed of prematurely
6. Designed for durability
7. Verified and certified in a 3M ISO 9001:2000 registered metrology lab to NIST traceable standards
8. May be used with 3M™ Shoe Electrode 741



*3M™ Dissipative  
Vinyl Three-Layer  
Mats and Runners  
8200 Series*

## Qualifying Questions

1. Do you power-up boards on the table mat?
2. Do you need a material that will offer cushioning for physical protection?
3. Do you need a material that will dissipate the charge in a controlled manner?
4. Do you need a material that will offer better surface-to-surface contact, which ensures excellent charge removal?

## Features/Advantages/Benefits

1. Top Layer – durable static dissipative vinyl, which has sufficient low resistance to discharge static-laden conductors (yet is resistive enough not to interfere with the “powering-up” of a circuit board in most cases.)
2. Middle Layer – highly conductive scrim provides main discharge path to ground
3. Bottom Layer – static dissipative foam, providing a durable non-skid cushion
4. Available as table mats/runners, floor mats/runners or in kit form
5. Available in three colors: brown, gray and blue

## Key Considerations

1. Thicker than other tri-layer mats
2. Works well with the 3M™ Monitors 724 and 725
3. Product has been choice of industry for more than 25 years
4. Will not support vertical combustion
5. Easily cleaned with 3M™ Static Control Surface Mark Remover 8001
6. Available in non-standard sizes



## *3M™ Dissipative Rubber Mats and Runners 8800 Series*

### **Qualifying Questions**

1. Do you want a material that you can solder on?
2. Do you want a material that can withstand harsh chemicals?
3. Do you want a material for clean rooms?
4. Do you need a lower profile mat?

### **Features/Advantages/Benefits**

1. Top Layer – durable static dissipative rubber, made from vulcanized synthetic rubber, which offers excellent resistance to oil, grease and most common solvents
2. Bottom Layer – conductive rubber offering superior resistance to chemicals
3. Superior resistance to heat and hot solder when compared with vinyl materials
4. Excellent for some clean rooms
5. Available as table mats/runners and floor mats/runners
6. Available in three colors: blue, gray and green

### **Key Considerations**

1. Low out-gassing characteristics when compared with alternative materials
2. Works well with the 3M™ Monitors 724 and 725
3. Excellent for use where harsh chemicals or soldering is required
4. Easily cleaned with 3M™ Static Control Surface Mark Remover 8001
5. Available in non-standard sizes



## *3M™ Mini Air Ionizer 960*

### **Qualifying Questions**

1. Do you have any material handling problems related to static?
2. Do you use any plastic in the assembly of your product that may present a threat to static sensitive devices, boards or other components in the work area?
3. Do you place labels on printed circuit boards?
4. Are you using tape for masking or identification during your assembly process?
5. Would the size of an ionizer or the noise be a consideration in your selection process?
6. What part does ease of use and maintenance play in you selection of ionizers?
7. Do you require UL or CE approvals on equipment used in your facility?
8. What would your selection criteria be for selecting ionizers?
9. Would a “self-balancing” ionizer be of interest to you?
10. Do you need an ionizer that can be installed within/included with your equipment?

### **Features/Advantages/Benefits**

1. Bi-polar neutralization
2. Proprietary intrinsically balanced design
3. Small and compact
4. Low fan noise
5. External power supply, 24 VAC wall transformer
6. UL/C-UL/CE registration

### **Key Considerations**

1. Takes up less space on the work surface as compared to other ionizers
2. Emits equal levels of positive and negative ions
3. Self-balancing
4. Designed specifically for electronics environments



## *3M™ Benchtop Air Ionizer 963/963E*

### **Qualifying Questions**

1. Do you have any material handling problems related to static?
2. Do you use any plastic in the assembly of your product that may present a threat to static sensitive devices, boards or other components in the work area?
3. Do you place labels on printed circuit boards?
4. Are you using tape for masking or identification during your assembly process?
5. Would the size of the ionizer or the noise be a consideration in your selection process?
6. What part does the ease of use and maintenance play in your selection of ionizers?
7. Do you require UL or CE approvals on equipment used in your facility?
8. What would your selection criteria be for selecting ionizers?
9. Would a “self-balancing” ionizer be of interest to you?

### **Features/Advantages/Benefits**

1. Bi-polar neutralization
2. Proprietary intrinsically balanced design
3. Small and compact
4. Low fan noise
5. Built-in power supply
6. No charge build-up on housing
7. Two-speed fan
8. 963-UL/C-UL/NOM certification
9. 963E-UL/C-UL/CE/NOM certification

### **Key Considerations**

1. Takes up less space on the work surface as compared to other ionizers
2. Emits equal levels of positive and negative ions
3. Self-balancing
4. Designed specifically for electronics environments
5. Injection molded case is static-dissipative plastic
6. Rapid neutralization



## *3M™ Ionized Air Gun 980/980E*

### **Qualifying Questions**

1. Are you presently air-blowing off your boards after aqueous cleaning?
2. Are you presently air-blowing out your units to remove dust and dirt before servicing or repairing?
3. Are your line workers complaining of fatigue or pain when using your presentsystem (i.e. Carpal Tunnel Syndrome)?
4. How do you check to see if your filters need to be replaced?

### **Features/Advantages/Benefits**

1. 980-UL, C-UL approved. 980E-UL, C-UL CE. Can be sold anywhere in the world
2. Extremely low level electromagnetic emissions
3. Ergonomic shape, with lightweight nozzle and hose. Will not cause fatigue to workers which will improve productivity
4. Standard air fittings with easy-view filter. Installation, repair and maintenance save money and time
5. Replaceable emitter points



*3M™ Overhead  
Air Ionizer 990*

**Qualifying Questions**

1. Are you trying to save space on the bench top work surface?
2. Do you have a larger work area to ionize?
3. Do you prefer an overhead air ionizer versus a bench top type?