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EIA STANDARD

Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices

EIA-625

NOVEMBER 1994

ELECTRONIC INDUSTRIES ASSOCIATION
ENGINEERING DEPARTMENT



EIA-625

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FOREWORD

This standard was prepared to standardize the requirements for a comprehensive Electrostatic Discharge (ESD) control program for handling ESD-Sensitive (ESDS) devices. The requirements within this standard were derived from existing industry standards, specifications, test methods, and input from various industry reviews.

The intent of this document is for users to incorporate these minimal requirements into their ESD control program to provide a consistent ESD protection level for their products.

This standard replaces JEDEC Standard No. 42 (formerly JEDEC Publication No. 108-B, Distributor Requirements for Handling Electrostatic-Discharge Sensitive (ESDS) Devices).

ELA-625

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CONTENTS

<u>Section</u>	<u>Page</u>
1. SCOPE	1
2. APPLICATION	1
2.1 Applicable Users	1
2.2 Applicable Part Types	1
3. RELATED DOCUMENTS	1
3.1 Applicable Documents	1
3.2 Informational/Reference Documents	2
4. DEFINITIONS	2
5. INSPECTION, MEASURING AND TEST EQUIPMENT	4
5.1 Calibration System	4
5.2 Recommended Inspection, Measuring and Test Equipment Types	4
6. FACILITIES FOR ESD PROTECTED AREAS AND WORKSTATIONS	4
6.1 Minimum Acceptable Requirements	4
6.2 ESD Item Check Records	9
6.3 Personnel Grounding	9
6.4 Wrist Strap and ESD Protective Footwear Resistance Path Checks	9
6.5 Static Voltage Measurements	10
6.6 ESD Signs and Labels	10
7. GROUNDING FOR PROTECTION OF ESDS DEVICES	11
7.1 ESD Ground	11
7.2 ESD Ground System Safety Review	11
7.3 ESD Protected Workstation ESD Ground	11
7.4 ESD Protected Work Surfaces	12
7.5 ESD Protective Flooring/Mats	12
7.6 ESD Ground Connections	12
7.7 Ground Wire Mechanical Considerations	12
7.8 Storage Areas	12
7.9 Mobile Equipment	13

CONTENTS

(continued)

<u>Section</u>	<u>Page</u>
8. ESD PACKAGING REQUIREMENTS FOR ESDS DEVICES	13
8.1 ESD Device Protective Packaging Requirement	13
8.2 Packing and Filler Materials	13
8.3 Antistatic Tubes, Magazines and Carriers	13
8.4 Individual Finished Device Carrier Materials	13
8.5 ESDS Device Wafer and Die Packing	13
8.6 ESDS Device Shipping and Receiving Operations	13
9. COMPLIANCE VERIFICATION	14
9.1 ESD Coordinator	14
9.2 ESD Protective Item Checks	14
9.3 Auditing	14
9.4 Noncompliance	14
9.5 Records	14
10. ESD TRAINING	14
10.1 Training Program	15
10.2 Training Records	15
11. METHODS FOR MINIMIZING STATIC CHARGING	15
11.1 Antistatic Solution	15
11.2 Relative Humidity Control	15
11.3 Air Ionizers	15
11.4 ESD Protective Smocks	16
11.5 Gloves/Finger Cots	16
ESD HANDLING AUDIT CHECKLIST	17

REQUIREMENTS FOR HANDLING ELECTROSTATIC-DISCHARGE-SENSITIVE (ESDS) DEVICES

(From Council Ballot JCB-93-64 and Standards Proposal No. 3018, formulated under the cognizance of JEDEC JC-13 Committee on Government Liaison.)

1. SCOPE

This standard establishes the minimum requirements for Electrostatic Discharge (ESD) control methods and materials used to protect electronic devices that are susceptible to damage or degradation from electrostatic discharge (ESD). The passage of a static charge through an electrostatic-discharge-sensitive (ESDS) device can result in catastrophic failure or performance degradation of the part.

ESD-sensitive devices are defined by appropriate documents (e.g., MIL-STD-883, Test Method 3015, MIL-HDBK-263). ESDS devices with human body model sensitivities of less than ± 200 volts may need additional protective measures beyond those specified in this standard.

2. APPLICATION

2.1 Applicable Users

- a) Semiconductor Manufacturers - from completion of wafer electrical probe (wafers/die packed for shipment to customers or assembly facilities) through shipment of finished devices except for in-process operations when all leads are shorted together.

NOTE: The requirements of this standard are not imposed prior to probed wafer/die shipment. Prior to probed wafer/die shipment, the manufacturer should take appropriate ESD precautions to minimize damage to devices.

- b) Semiconductor Distributors - from receipt through shipment of finished devices.
- c) Semiconductor Processing/Testing Facilities - from receipt through shipment of finished devices.
- d) Semiconductor Users - from receipt of semiconductor wafers, die and/or finished devices through board assembly or any other operation where individual electrostatic-discharge-sensitive (ESDS) devices are handled.

2.2 Applicable Device Types

The device types for which these requirements are applicable include, but are not limited to, ESD-sensitive discrete and integrated circuit semiconductors, hybrid microcircuits, and thin film passive devices.

NOTE: ESD susceptibility/sensitivity can be determined and specified by the manufacturer or user.

3. RELATED DOCUMENTS

Unless otherwise specified, the following documents of the latest issue, revision or amendment, form a part of this standard to the extent specified herein.

3.1 Applicable Documents

ANSI/ASQC-M1	American National Standard for Calibration Systems
ANSI/ASQC-Q9001	Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing (US version of ISO-9001)
ANSI/ASQC-Q9002	Quality Systems - Model for Quality Assurance in Production and Installation (US version of ISO-9002)
EIA-471	Symbol and Label for Electrostatic Sensitive Devices
EIA-541	Packaging Materials Standards for ESD Sensitive Items

EOS/ESD-S3.1	Standard for Protection of Electrostatic Discharge Susceptible Items - Ionization
EOS/ESD-S4.1	Standard for Protection of Electrostatic Discharge Susceptible Items - Worksurfaces - Resistive Characterization
EOS/ESD-S6.1	Standard for Protection of Electrostatic Discharge Susceptible Items - Grounding - Recommended Practice
EOS/ESD-S7.1	Standard for Protection of Electrostatic Discharge Susceptible Items - Floor Materials - Resistive Characterization of Materials
MIL-STD-883	Test Method 3015 Electrostatic Discharge Sensitivity Classification
MIL-HDBK-263	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-45662	Calibration System Requirements

3.2 Informational/Reference Documents

ASTM-D257	DC Resistance or Conductance of Insulative Materials
ASTM-D991	Rubber Property - Volume Resistivity of Electrically Conductive and Antistatic Products
EOS/ESD-ADV1.0	EOS/ESD Association Glossary of Terms
EOS/ESD-S1	Standard for Protection of Electrostatic Discharge Susceptible Items - Personal Grounding Wrist-Straps
EOS/ESD-S5.1	Human Body Model (HBM) Electrostatic Discharge (ESD) Sensitivity Testing Standard
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
MIL-W-87893	Workstations, Electrostatic Discharge Control
NAVSEA SE 003-AA-TRN-010	Electrostatic Discharge Training Manual
TECHNICAL ORDER (TO) 00-25-234, SECTION VII	Electrostatic Discharge (ESD) Control

4. DEFINITIONS

- 4.1 air ionizer - A source of charged air molecules (ions).
- 4.2 antistatic - Referring to the property of material that inhibits triboelectric charging. For purposes of this standard, antistatic materials shall not triboelectric charge to greater than ± 200 volts under normal/intended usage. A material's antistatic property is not necessarily correlatable with its resistivity or resistance.
- 4.3 conductive material - A material that has a surface resistivity less than 1×10^5 ohms/square or a volume resistivity less than 1×10^4 ohm-cm. A conductive material is not necessarily antistatic.
- 4.4 electrostatic charge (See static electricity)
- 4.5 electrostatic discharge (ESD) - The transfer of electrostatic charge between bodies or surfaces that are at different electrostatic potentials.

- 4.6 **electrostatic-discharge susceptibility (sensitivity) (ESDS)** - A measure of the susceptibility (sensitivity) of a device to ESD damage. Susceptibility or sensitivity is that level of ESD that produces changes in device characteristics such that a device fails to meet its specified parameters.
- 4.7 **electrostatic field** - Lines of force surrounding an electrically charged object.
- 4.8 **electrostatic shielding** - A barrier or enclosure that limits the penetration of an electrostatic field so that its effects do not reach the stored or contained devices and produce damage. (see EIA-541)
- 4.9 **equipment ground** - The entire low-impedance path from a piece of electrical equipment to a hard-ground electrode. The third wire (green) of an AC Power receptacle.
- 4.10 **ESD ground** - The point, electrodes, bus bar, metal strips, or other system of conductors that form a path from a statically charged person or object to ground.
- 4.11 **ESD-protected area** - A work environment with materials and equipment that limit electrostatic voltages.
- 4.12 **ESD-protected workstation** - A work position with materials and equipment that limit electrostatic voltages.
- 4.13 **ESD-protective packaging** - A packaging system that provides electrostatic shielding and limits triboelectric charging for ESDS devices.
- 4.14 **ground** - (1) A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of earth. (2) The position or portion of an electrical circuit at zero potential with respect to the earth. (3) A conducting body, such as the earth or the hull of a steel ship used as a return path for electric currents and as an arbitrary zero reference point.
- 4.15 **groundable point** - A designated connection, location, or assembly used on an ESD protective material or device that is intended to accommodate electrical connection from the device to ESD ground.
- 4.16 **insulative material** - A material having a surface resistivity of at least 1×10^{12} ohms/square or 1×10^{11} ohm-cm volume resistivity.
- 4.17 **static** - As used in this standard, a short form of electrostatic.
- 4.18 **static dissipative material** - A material having a surface resistivity of at least 1×10^5 ohms/square or 1×10^4 ohm-cm volume resistivity, but less than 1×10^{12} ohm/square surface resistivity or 1×10^{11} ohm-cm volume resistivity.
- 4.19 **static electricity** - Electrical charge at rest. The electrical charge is due to the transfer of electrons within a body (polarization) or from one body to another.
- 4.20 **surface resistance** - The ratio of dc voltage to the current passing between two electrodes of specified configuration that contact the same side of a material or item. Surface resistance is expressed in ohms.
- 4.21 **surface resistivity (sheet-resistance) (ρ_s)** - The ratio of dc voltage to the current that passes across the surface of a square unit of area. The surface resistivity is the resistance between two opposite sides of a square and is independent of the size of the square or its dimensional units. Surface resistivity is expressed in ohms/square. When using a concentric ring fixture, as described in ASTM-D257, surface resistivity is calculated by using the following expression:

$$\text{surface resistivity } (\rho_s) = \pi \times \frac{(D2 + D1)}{(D2 - D1)} \times R$$

where D2 = inside diameter of outer electrode
D1 = outside diameter of inner electrode
R = measured resistance in ohms

- 4.22 **triboelectric charging** - The generation of electrostatic charges when two pieces of material in intimate contact are separated (where one or both is an insulator). Substantial generation of static electricity can be caused by contact and separation of two materials or rubbing two substances together.
- 4.23 **unprotected ESDS device** - An ESDS device that is not in an ESD protective package per 4.13.
-

- 4.24 volume resistivity (ρ_v) - The ratio of the dc voltage per unit thickness, applied across two electrodes in contact with a specimen, to the amount of current per unit area passing through the system. Volume resistivity is generally given in ohm-centimeters. When using a concentric ring fixture, as described in ASTM-D991, volume resistivity is calculated by using the following expression:

$$\text{volume resistivity } (\rho_v) = \pi \times \frac{(D_i)^2}{4T} \times R$$

where D_i = diameter of inner electrode or disk
 R = measured resistance in ohms
 T = thickness of specimen

5. INSPECTION, MEASURING AND TEST EQUIPMENT

5.1 Calibration System

The calibration system for all inspection, measuring and test equipment used to perform required ESD Item Checks listed in Table 2 shall be compliant with the requirements of MIL-STD-45662 or ANSI/ASQC-Q9001/Q9002 and ANSI/ASQC-M1.

5.2 Recommended Inspection, Measuring and Test Equipment Types

The recommended test equipment types and capabilities are listed below:

- a) A Go/No-go tester, a meter, an in-line monitor, or equivalent resistance path measuring equipment shall be capable of measuring the resistance of each connection path (e.g., wrist strap, heel strap or ESD protective footwear) (see 6.4.1 and 6.4.2) within the Table 2 limits.
- b) When wrist strap monitoring equipment is used, it shall alarm (audio and/or visual) when a wrist strap exceeds the limits specified in Table 2 and when there is a broken or missing connection to the user.
- c) Electrostatic voltmeters shall be capable of verifying the presence of static voltages greater than ± 200 volts. Electrostatic voltmeters used in ionized air streams shall be constructed (e.g., chopper-stabilized) to operate in that environment.
- d) Meters used to verify ESD ground continuity shall be capable of verifying resistance values less than one ohm.
- e) Meters use to measure surface resistance to ground and surface resistance shall be capable of verifying resistance values within the Table 2 limits.
- f) Meters used to measure surface resistivity shall be capable of verifying resistivity values within the Table 2 limits.
- g) Electrostatic charged plate monitors shall be capable of measuring the charge neutralization properties of ionization equipment within the Table 2 limits.

6. FACILITIES FOR ESD PROTECTED AREAS AND WORKSTATIONS

6.1 Minimum Acceptable Requirements

The minimum acceptable requirements for ESD protected areas and workstations are listed in Table 1 and illustrated in Figure 1. The required ESD item checks are listed in Table 2 and the optional check frequency adjustment procedure is listed in Table 3.

Table 1 - Minimum Requirements for ESD Protected Areas and Workstations

ITEM	MINIMUM REQUIREMENTS
1. ESD Protective Work Surface	Where unprotected ESDS devices are handled, a grounded static dissipative work surface shall be used unless the manufacturing process necessitates a grounded conductive/highly conductive work surface.
2. ESD Protective Flooring or Floor Mats	Grounded flooring or floor mats are only required when personnel or mobile ESD protective workstations utilize floor grounding methods.
3. Personnel Grounding	<p>Each person handling or within twelve (12) inches of unprotected ESDS devices shall be grounded using <u>EITHER</u>:</p> <ul style="list-style-type: none"> a) Wrist straps that shall <ul style="list-style-type: none"> 1) Provide a continuous electrical path from the user directly to ESD ground. 2) Have an integral resistance at the wrist band end of the grounding wire that will limit current to less than 0.5 mA at the highest power supply voltage that may be encountered. b) ESD protective footwear (heel straps, toe straps or conductive shoes) that shall <ul style="list-style-type: none"> 1) Provide a continuous electrical path from the user directly to the ESD protective flooring or floor mat. 2) Be worn on both feet. 3) Limit current to less than 0.5 mA at the highest power supply voltage that may be encountered. 4) <u>NOT</u> be relied upon for grounding of seated personnel.
4. Static Generating Sources	<ul style="list-style-type: none"> a) Nonessential and personal items shall not be placed on ESD protective work surfaces. b) Essential materials/items, during normal/intended use, shall not cause static voltages greater than ± 200 volts to be within twelve (12) inches of unprotected ESDS devices. c) Operations, equipment or clothing generating static voltages greater than ± 200 volts within twelve (12) inches of unprotected ESDS devices shall be neutralized or reduced to less than ± 200 volts.
5. ESD Protective Smocks	ESD protective smocks may be used to prevent clothing from generating static voltages greater than ± 200 volts. When ESD protective smocks are worn, they shall cover all personal garments above the waist except at the neck area.
6. Air Ionizers	Air ionizers may be used to reduce static voltages generated by operations, equipment or clothing to less than ± 200 volts within twelve (12) inches of unprotected ESDS devices if those voltages are not controlled by other means.
7. ESD Protected Area and Workstation Identification	ESD caution signs shall be posted at each ESD protected workstation and/or at the entrances of defined ESD protected areas.

Table 2
Required ESD Protective Item Checks

FREQUENCY (see Note 1)	ITEMS	ACCEPTANCE LIMITS	REF. PARA.
1. Daily	a) Wrist straps (see Note 2).	$\geq 250 \text{ k}\Omega$ to $\leq 10 \text{ M}\Omega$ for 120 V	6.4/ 6.4.1
		$\geq 500 \text{ k}\Omega$ to $\leq 10 \text{ M}\Omega$ for 240 V	6.4/ 6.4.1
	b) ESD protective footwear (see Note 3).	$\geq 250 \text{ k}\Omega$ to $\leq 10^9 \Omega$ for 120 V	6.4/ 6.4.2
		$\geq 500 \text{ k}\Omega$ to $\leq 10^9 \Omega$ for 240 V	6.4/ 6.4.2
	c) Personnel ESD protective smock (e.g., buttoned smocks) on personnel required to wear them.	Visual check	11.4
	d) Wrist straps or ESD protective footwear on personnel required to wear them.	Visual check	6.3
2. Weekly	a) ESD protected workstation. (e.g., ground connections)	Visual check	7.3/ 7.4.1/ 7.4.2
	b) ESD protective floor mat (e.g., cleanliness and freedom from tears).	Visual check	7.3/ 7.5
	c) ESD ground connections (e.g., wrist straps, mat ground wires).	Visual check	7.3/ 7.6
3. Monthly	a) ESD protected area and workstation static voltage surveys.	$\leq \pm 200$ volts within 12 inches of unprotected ESDS devices	6.5
	b) ESD protective smocks.	$\leq \pm 200$ volts	11.4c
4. Quarterly	a) ESD protective static dissipative work surface to ESD ground resistance (See Note 4).	$\geq 10^5$ to $< 10^{10} \Omega$	7.3/ 7.4.1/ 4.18
	b) ESD highly conductive (e.g., stainless steel) work surface to ESD ground resistance. (see Note 4)	$< 1.0 \Omega$	7.3/ 7.4.2
	c) ESD conductive (see 4.3) work surface to ESD ground resistance. (see Note 4)	$< 100 \text{ k}\Omega$ (with no series resistor)	7.3/ 7.4.3
		$< 1.1 \text{ M}\Omega$ (with series resistor)	7.3/ 7.4.3
	d) ESD protective floor to ESD ground resistance (See Note 5).	$< 10^9 \Omega$ (see Note 8)	7.5

Table 2
Required ESD Protective Item Checks
(continued)

FREQUENCY (see Note 1)	ITEMS	ACCEPTANCE LIMITS	REF. PARA
4. Quarterly (continued)	e) ESD protective floor surface point-to-point resistance using EOS/ESD-S7.1.	$< 10^9 \Omega$ (see Note 8)	7.5
	OR		
	ESD protective floor surface resistance using ASTM F150 at 100 volts.	$< 10^9 \Omega$ (see Note 8)	7.5
	f) Wrist strap monitor check.	$\geq 250 \text{ k}\Omega$ to $\leq 10 \text{ M}\Omega$ for 120 V	6.4.3
		500 k Ω to $\leq 10 \text{ M}\Omega$ for 240 V	6.4.3
	g) ESD ground continuity from the groundable point (e.g., shelving ground wires, mobile equipment ground wires, cord ground wires) using EOS/ESD-S6.1. (see Note 6)	$\leq 1.0 \Omega$	4.10/ 7.6./ 7.7/ 7.8/ 7.9.2
5. Semi-annually	a) Ionizer balance using EOS/ ESD-S3.1. (see Note 7)	Balance $< \pm 35 \text{ V}$	11.3e
	b) Ionizer charge decay performance using EOS/SD-S3.1.	Charge decay performance per manufacturer's specification.	11.3f
6. Annually	ESD system compliance to the requirements of this standard	Using the ESD Audit Checklist or equivalent.	9.3

NOTES

- The ESD item checks shall be performed more frequently than listed when compliance is not continuously maintained.
- Wrist straps shall be checked at least once a day when continuous wrist strap monitors are not used.
- ESD protective footwear is available in a wide range of resistance values. Those with mid-to-lower resistance values provide shorter charge dissipation times.
- Use EOS/ESD-S4.1 except make a single measurement using the limits specified in this standard at a high wear point relative to the ground connection on the work surface to the ESD ground (instead of several points to the groundable point). All ESDS devices shall be removed from the worksurface while making these measurements.
- Use EOS/ESD-S7.1 except make a single measurement from a point on the floor to the ESD ground (instead of the groundable point).
- If a resistor is used in the circuit, the resistance limit shall include the value of the resistor.
- Use EOS/ESD-S3.1, except a single measurement point can be used for benchtop ionizing systems. Air velocity measurements are not required.
- 100k ohms is a suggested lower limit. However, a lower value may be used if local safety requirements can still be met.

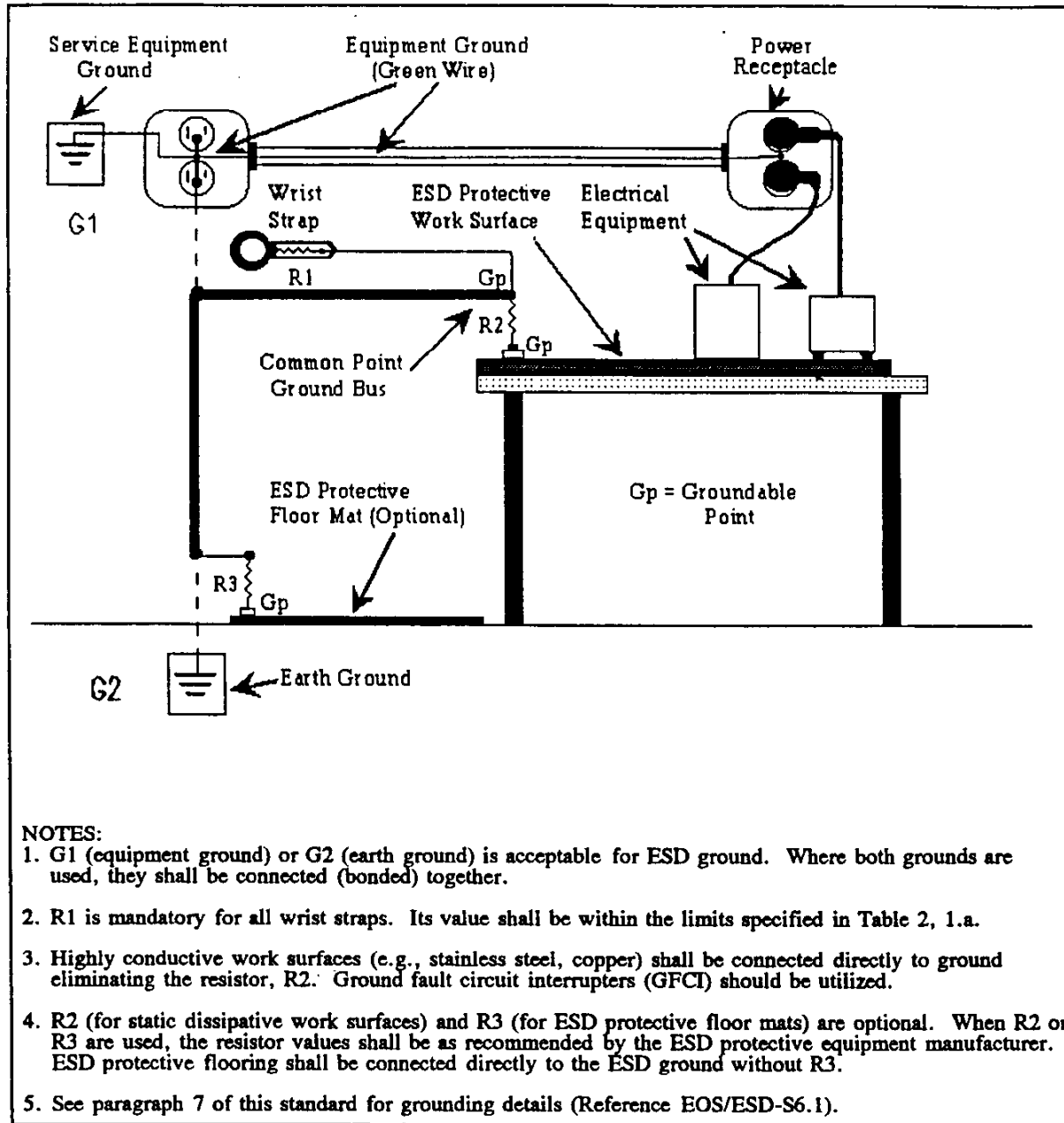


Figure 1
ESD Protected Workstation (Side View)

Table 3
Optional ESD Protective Item Check Frequency Adjustment

CHECK FREQUENCY	MINIMUM CONTINUOUS TIME WITH NO FAILURES BEFORE CHECK FREQUENCY ADJUSTMENT IS ALLOWED
Weekly	2 months
Monthly	6 months
Quarterly	1 year
Semiannually	2 years
CHECK FREQUENCY ADJUSTMENT CRITERIA~ 1. To change the check frequency (e.g., from weekly to monthly), the entire ESD protective item population must meet the minimum continuous time with little failures and contain at least 30 checks in the item population. A population is a selected group of an item to be checked per Table 3. 2. The check frequency shall not be changed by more than one level at a time and no more than two (2) levels from that specified in Table 2 (e.g., weekly to quarterly). 3. One (1) failure within the item population moves the check frequency back one (1) level for the item population. 4. The daily and annual ESD protective item check frequencies shall not be reduced.	

6.2 ESD Item Check Records

Records of the Table 2 ESD item checks shall be maintained for a minimum of one year except for continuously monitored items and visual checks that do not require written records.

- Compliant resistance, capacitance, and voltage measurements may be recorded either as variables (the measured values) or attributes (pass).
- Noncompliant measurements must be recorded using variables (the measured values) when the measuring equipment is capable of providing variables. Otherwise, the attribute (fail) must be recorded.

6.3 Personnel Grounding

Personnel handling or within twelve (12) inches of unprotected ESDS devices shall be grounded per Table 1.

6.4 Wrist Strap and ESD Protective Footwear Resistance Path Checks

While being worn, the resistance paths of wrist straps, heel/toe straps and conductive shoes shall be independently checked to the Table 2 limits for minimum resistance (to provide current limiting characteristics) and maximum resistance (to ensure that adequate body contact is maintained).

6.4.1 Wrist Strap Resistance Measurement Path

The wrist strap resistance path is measured from the user's hand, through the user's body, the body-to-strap contact, the integral resistor, the strap wire, to the strap ground connector.

6.4.2 Heel/Toe Straps and Conductive Shoes Resistance Measurement Paths

Each heel/toe strap and conductive shoe resistance path shall be individually measured from the user's hand, through the user's body, the body-to-strap/shoe contact, the strap/shoe to the conductive plate.

6.4.3 Wrist Strap Monitor

When wrist strap monitoring equipment is used, daily wrist strap checks and logs are not required. Corrective actions resulting from monitor alarms shall be documented.

6.5 Static Voltage Measurements

An electrostatic voltmeter shall be used to verify that static voltages are compliant to the Table 2 limit.

6.6 ESD Signs and Labels

6.6.1 Sign Content and Posting

ESD caution signs shall be posted to clearly indicate the ESD protected area boundaries and workstations to all approaching personnel. These signs shall indicate by words and/or symbol that ESD HANDLING IS REQUIRED in the area and/or at the workstation. An example of an acceptable ESD caution symbol is shown in EIA-471.

6.6.2 ESD Caution Labels for Packing and Shipping

Each ESD protective package shall have a contrasting ESD caution label. The caution label shall be legible to normal vision at a distance of three feet.

Monochromatic reproduction in any color that contrasts with the background may be used. Where the choice of color is arbitrary, it is suggested that the symbol be black on a yellow background. Wherever possible, the color red for the symbol should be avoided as red suggests a personnel hazard (Reference EIA-471).

6.6.3 Package ESD Caution Label Content

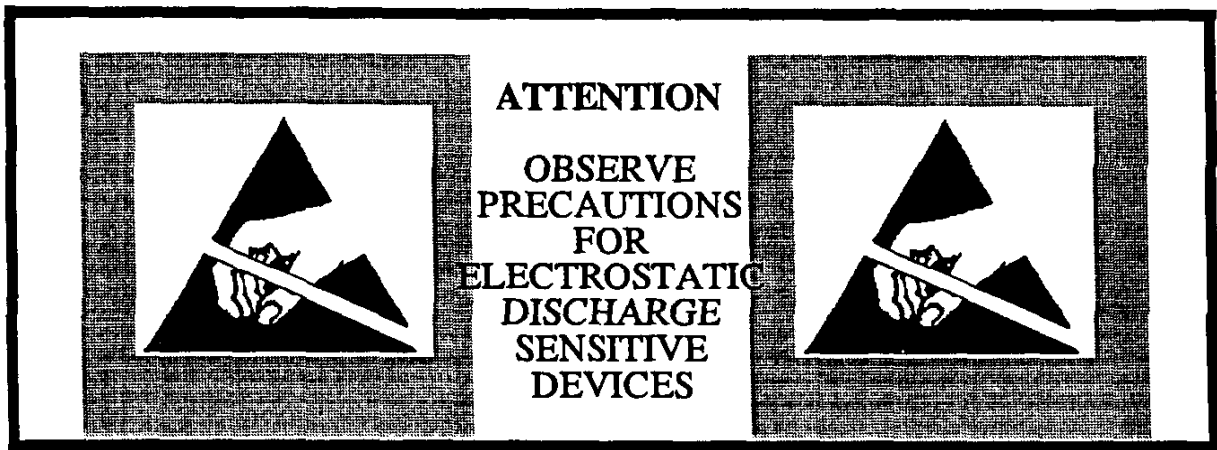


Figure 2
ESD Protected Package Caution Label Example

The label shall clearly indicate by words and/or symbol that ESDS devices are inside the package and that the package cannot be opened except at a designated ESD protected area or workstation. An example of an ESD Protected Package Caution label is shown in Figure 2.

6.6.4 Commercial Device Package ESD Caution Label

For commercial devices, each ESD protective package shall have an ESD caution label placed in a standard location to ensure that people will be aware that ESDS devices are inside the packages. The ESD caution label on the package may be provided by a preprinted marking on the package or its sealing tape.

6.6.5 Military Device Package ESD Caution Label

For military devices, the ESD caution label and its position shall conform to the requirements of MIL-STD-129.

7. GROUNDING FOR PROTECTION OF ESDS DEVICES

7.1 ESD Ground

The ESD ground shall be the equipment ground or earth ground. Equipment ground is the electrical ground (green) wire at receptacles that have been tested to and meet the requirements of NFPA-70.

A typical grounding system for an ESD protected workstation is illustrated in Figure 1.

7.1.1 Earth and Equipment ESD Grounds

Equipment ground should be used instead of earth ground. When both equipment and earth grounds are used at the same ESD protective workstation they shall be bonded together at some point in the ground system.

7.1.2 Equipment Grounding Receptacle and Conductor Testing

The equipment grounding receptacle and conductors shall be tested in accordance with NFPA-70 after being installed or modified and prior to being used.

NOTES:

1. ESD grounding conditions shall conform to the applicable building, electrical and safety codes and standards.
2. The ESD ground systems specified and described in this standard are in accordance with the EOS/ESD-S6.1 which is coordinated with and compliant to ANSI/NFPA-70 and ANSI/IEEE Standard 142 (IEEE Green Book).

7.2 ESD Ground System Safety Review

The Site Safety Engineer (or designated person) should perform a safety review of all new or modified ESD Ground connections at the ESD Protected workstation prior to their initial use.

7.3 ESD Protected Workstation ESD Ground

The design and construction of the grounded ESD protected workstation and associated equipment shall ensure that all external parts, surfaces, and shields of electrical equipment and power tools are at ground potential at all times. Each ESD workstation shall be individually connected to the ESD ground. When more than one ESD work surface is used at a workstation, each surface shall be individually connected to the ESD ground.

7.4 ESD Protective Work Surfaces

7.4.1 Static Dissipative ESD Protective Work Surfaces

Static dissipative ESD protective work surfaces are preferred. A direct connection to ground is recommended. A resistor in the grounding wire is optional.

It is recommended that new and upgraded installations have a surface resistance and a resistance to ESD ground of $\geq 10^5$ and $\leq 10^9 \Omega$.

7.4.2 Highly Conductive ESD Protective Work Surfaces

When highly conductive ESD protective work surfaces are required due to the manufacturing process needs (e.g., stainless steel), they shall be connected directly to ESD ground without a series resistor to ensure they are continuously at ground potential.

NOTE: Ground fault circuit interrupters (GFCI) should be utilized.

7.4.3 Conductive ESD Protective Work Surfaces

Conductive ESD protective work surfaces shall be connected directly to ESD ground or have an optional resistor in a series connection to ESD ground.

7.5 ESD Protective Flooring/Mats

ESD protective flooring/mats are required when floor grounding devices (ESD protective footwear and/or mobile ESD protected workstations) are utilized. ESD protective flooring/mats shall be connected to ESD ground.

ESD protective flooring shall be connected directly to ESD ground. An optional resistor may be used to connect ESD protective floor mats to ESD ground. It is recommended that ESD protective floor mats be connected directly to ESD ground without a series resistor.

7.6 ESD Ground Connections

Firm fitting connecting devices such as metallic crimps, snaps and banana plugs shall be connected to designated ground points. Wire splices should be crimped or soldered. Use of alligator clips is not recommended.

7.7 Ground Wire Mechanical Considerations

The wire used to connect the ESD ground to equipment ground should be of sufficient strength not to be inadvertently broken or disconnected. The wire should be attached to physical structures to prevent mechanical damage.

7.8 Storage Areas

Shelving used as an ESD protected area or workstation shall meet all of the requirements for an ESD protected area or workstation per paragraph 6 and Tables 1 and 2.

When the storage shelving is not an ESD protected area or workstation, the ESDS devices shall be in ESD protective packaging.

7.9 Mobile Equipment

7.9.1 Mobile Equipment Electrostatic Voltage Limit

Mobile equipment (e.g., carts, chairs, tables) shall not generate electrostatic voltages greater than ± 200 volts within twelve (12) inches of unprotected ESDS devices during use.

7.9.2 Mobile ESD Protected Workstation

When mobile equipment is used as an ESD protected workstation (e.g., cart, table), it shall be connected to ESD ground and meet the requirements for an ESD protected workstation per Table 1 (see 4.12). When a floor grounding device (e.g., drag chain, drag wire, conductive castor) is used to ground a mobile ESD protected workstation, an ESD protective floor/mat is required.

8. ESD PROTECTIVE PACKAGING REQUIREMENTS FOR ESDS DEVICES

8.1 ESDS Device Protective Packaging Requirement

All ESDS devices shall be packed in ESD protective packaging (see 4.13) when not at an ESD protected area or workstation.

8.2 Packing and Filler Materials

Packing and filler materials for ESDS devices shall not triboelectric charge to greater than ± 200 volts under normal/intended use (antistatic per 4.2).

8.3 Antistatic Tubes, Trays, Magazines and Carriers

Antistatic (antistat-solution-treated) tubes, trays, magazines and carriers provide mechanical protection for devices and minimize triboelectric charging. Applying or removing static generating tapes and labels to antistatic tubes, magazines and carriers shall not be done with ESDS devices inside while the generated static voltages exceed ± 200 volts.

8.4 Individual Finished Device Carrier Materials.

Insulating (see 4.16) carrier materials may be used for individual finished devices (e.g., to allow electrical testing) providing the handling methods minimize triboelectric charging of the carriers and surrounding materials and static voltages on the carriers do not exceed ± 200 volts.

8.5 ESDS Device Wafer and Die Packing

ESDS wafers and dice shall be packed using materials that do not triboelectric charge to greater than ± 200 volts under normal/intended use (antistatic per 4.2).

NOTE: ESD materials that will be inside wafer and die containers should be selected to avoid contamination of the devices.

8.6 ESDS Device Shipping and Receiving Operations

All ESDS devices must be shipped and received in ESD protective packaging, which must not be opened except at an ESD protected area or workstation.

9. COMPLIANCE VERIFICATION

9.1 ESD Coordinator/Team

Each site shall have a designated ESD coordinator/team. The coordinator/team is responsible for assuring that the requirements of this standard are met.

9.2 ESD PROTECTIVE ITEM CHECKS

The frequencies for ESD protective item checks listed in Table 2 shall be maintained. The optional check frequency adjustment may be used when consecutive ESD protective item check results meet the requirements of Table 3.

9.3 Auditing

An audit is to be performed for each operation involving the processing, handling or storage of ESDS devices, at least once a year, to verify compliance with the requirements of this standard.

9.4 Noncompliance

When noncompliances to the requirements of this standard are found, both the noncompliance and their causes shall be corrected and the corrective actions shall be documented.

9.4.1 Noncompliant ESD Protected Areas and Workstations

When noncompliant ESD protected areas and/or workstations are found, no additional devices can be processed through that area and/or workstation until the noncompliance is corrected.

9.4.2 Mishandled ESDS Devices

Documented procedures shall define the dispositioning of ESDS devices/ wafers that have NOT been continuously handled, packaged and transported according to this standard.

9.4.3 Returning Rejected ESDS Devices to Suppliers

Rejected (e.g., electrical, mechanical) ESDS devices being returned to suppliers, shall be handled and shipped in accordance with the requirements of this standard. When the supplier's original packing materials and containers are noncompliant to this standard, the ESDS devices shall be rejected and returned in the original materials and containers.

9.5 Records

Written records shall be kept of all audits per 9.3 and inspection, measuring and test equipment calibrations for at least 2 years. As a minimum, audit records shall specify what was audited, the auditor's name, date of audit, audit results, corrective actions required (if applicable), and evidence of verification of satisfactory completion of any required corrective actions.

10. ESD HANDLING TRAINING

All personnel handling ESDS devices shall receive ESD handling training initially and a minimum of every 12 months thereafter to maintain proficiency.

NOTE: Personnel who enter ESD protected areas should receive ESD awareness training.

10.1 Training Program

The ESD handling training should include static fundamentals, a review of applicable parts of this specification, and actual applications in the work area.

10.2 Training Records

Training records shall be maintained for each individual. As a minimum, the records shall show dates of training, length of training session, topics covered, and the name of the trainer. Records shall be maintained for at least two (2) complete years.

11. METHODS FOR MINIMIZING STATIC CHARGING

Static charge preventive actions shall be utilized at ESD protected areas and workstations where static voltages greater than ± 200 volts ARE measured AND unprotected ESDS devices are within twelve (12) inches of the charged sources.

Charge prevention/neutralization methods include, but are not limited to, antistatic solution treatments, relative humidity control, air ionizers, sleeve protectors, and ESD protective smocks.

11.1 Antistatic Solution

Antistatic chemicals (antistat solutions) can be used to prevent static charge generation on static generating/charging materials in the work or storage areas. During application of any antistatic chemical, the user must consider the following:

- a) The antistatic solutions should be chosen to avoid contamination of ESDS devices.
- b) Antistatic spray or solutions must not be applied in any form to energized electrical parts, assemblies, panels, or equipment.
- c) Antistatic solutions should not be applied when devices and/or packages are directly exposed to spray mists.
- d) The need for initial application and frequency of reapplication can only be established through routine static voltage measurements during normal operations using an electrostatic voltmeter.

11.2 Relative Humidity Control

Relative humidity has a significant impact on the generation of static electricity and its control is recommended where practicable.

NOTE: The recommended minimum humidity is 40% R.H.

11.3 Air Ionizers

Air ionizers, when used, shall conform to the following:

- a) Table ionizers shall be positioned so that the devices at the ESD-protected workstations are within the ionizer manufacturer's specified coverage area. The ionizer shall be aimed at the devices and operator's hands rather than at the operator.

- b) Ceiling ionizers shall be oriented in relation to the work surfaces in accordance with the ionizer manufacturer's instructions.
- c) Devices shall not be brought closer to the ionizer than specified by the ionizer manufacturer.
- d) There shall be an unrestricted, straight line air flow between the ionizers and the unprotected devices.
- e) Ionizer balance (positive and negative ions) shall be verified per Table 2.
- f) Ionizer charge decay performance shall be verified using the method described in EOS/ESD-S3.1 per Table 2.

11.4 ESD Protective Smocks

ESD protective smocks, when worn, shall accomplish the following:

- a) The ESD protective smocks shall be buttoned (except for the collar) whenever the wearer is at an ESD protected workstation or in a designated ESD protected area.
- b) The ESD protective smock manufacturer's cleaning instructions should be followed to gain maximum effectiveness and utility from the smocks.
- c) Smocks with static voltages greater than ± 200 volts shall be removed from service.

11.5 Gloves/Finger Cots

When gloves or finger cots are used, only cotton gloves, antistatic/conductive gloves, or antistatic/conductive finger cots should be used when handling ESDS devices.

ESD AUDIT CHECKLIST

Auditor: _____

Date: _____

Area: _____

Audited: _____

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
1	-	Does the calibration system for all inspection, measuring and test equipment used to perform required ESD item checks listed in Table 2 meet the requirements of MIL-STD-45662 or ANSI/ASQC-Q9001/Q9002 and ANSI/ASQC-M1? (5.1)
2	-	When a Go/No-go tester, a meter, an in-line monitor, or equivalent resistance path measuring equipment is used, is it capable of measuring resistance values within the Table 2 limits? (5.2a)
3	-	When wrist strap continuous monitoring equipment is used, does it alarm (audio and/or visual) when a wrist strap exceeds the limits specified in Table 2 and when there is a broken or missing connection to the user? (5.2b)
4	-	Are the electrostatic voltmeters capable of verifying the presence of voltages greater than ± 200 volts? (5.2c)
5	-	Are the electrostatic voltmeters used in ionized air streams constructed (e.g., chopper stabilized) to operate in that environment? (5.2c)
6	-	Are the meters used to verify ESD ground continuity capable of verifying resistance values of less than 1 Ω ? (5.2d)
7	-	Are the meters used to measure work surface resistance to ground and surface resistance capable of verifying resistance values within the Table 2 limits? (5.2e)
8	-	Are the meters used to measure surface resistivity capable of verifying resistivity values within the Table 2 limits? (5.2f)
9	-	Are the electrostatic charged plate monitors capable of measuring the charge neutralization properties of ionization equipment within the Table 2 limits? (5.2g)
10	-	Where unprotected ESDS devices are handled, are grounded static dissipative work surfaces used except when the manufacturing process necessitates a grounded conductive work surface? (Table 1-1)
11	-	Are grounded flooring or floor mats covering the floor areas where personnel or mobile ESD protective workstations are using floor grounding methods? (Table 1-2)
12	-	Is each person handling or within twelve (12) inches of unprotected ESDS devices grounded by either a wrist strap or ESD protective footwear? (Table 1-3a,b)
13	-	When wrist straps are used, are they providing a continuous electrical path from the user's body directly to ESD ground? (Table 1-3a1)
14	-	Do the wrist straps have an integral resistance at the wrist band end of the grounding wire that limits current to less than 0.5 mA at the highest power supply voltage that can be encountered? (Table 1-3a2)

ESD AUDIT CHECKLIST

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
15	-	When personnel floor grounding methods are used, does the ESD protective footwear (heel straps, toe straps or conductive shoes) provide a continuous electrical path from the user to the ESD protective flooring or floor mat? (Table 1-3b1)
16	-	When personnel floor grounding methods are used, is the ESD protective footwear worn on both feet? (Table 1-3b2)
17	-	Does the ESD protective footwear limit current to less than 0.5 mA at the highest power supply voltage that can be encountered? (Table 1-3b3)
18	-	Is ESD protective footwear <u>NOT</u> used for grounding seated personnel? (Table 1-3b4)
19	-	Are nonessential and personal items kept off of the ESD protective work surfaces? (Table 1-4a)
20	-	Are the static voltages generated by essential materials/items less than ± 200 volts within twelve (12) inches of unprotected ESDS devices? (Table 1-4b)
21	-	When operations, equipment or clothing are capable of generating static voltages greater than ± 200 volts within twelve (12) inches of unprotected ESDS devices, are the static voltages neutralized or reduced to less than ± 200 volts? (Table 1-4c)
22	-	When ESD protective smocks are used to prevent clothing generated static voltages greater than ± 200 volts from being within twelve inches of unprotected ESDS devices, do the smocks cover all personal garments above the waist except at the neck area? (Table 1-5)
23	-	When air ionizers used, are there no static voltages generated by operations, equipment or clothing greater than ± 200 volts within twelve (12) inches of unprotected ESDS devices? (Table 1-6)
24	-	Are ESD caution signs posted at each ESD protected workstation and/or at the entrances of defined ESD protected areas? (Table 1-7)
25	-	Are the daily wrist strap checks being performed? (Table 2-1a)
26	-	Are the daily ESD protective footwear checks being performed? (Table 2-1b)
27	-	Are the daily ESD protective smock visual checks being performed? (Table 2-1c)
28	-	Are the daily personnel grounding visual checks being performed? (Table 2-1d)
29	-	Are the ESD protected workstation visual checks being performed per Table 2-2a?
30	-	Are the ESD protective floor mat visual checks being performed per Table 2-2b?
31	-	Are the ESD ground connection visual checks being performed per Table 2-2c?
32	-	Are the ESD protected area and workstation static voltage surveys being performed per Table 2-3a?
33	-	Are the ESD protective smocks being checked for static voltages per Table 2-3b?

ESD AUDIT CHECKLIST

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
34	-	Are the ESD protective static dissipative work surface to ESD ground resistance checks being performed per Table 2-4a?
35	-	Are the ESD protective highly conductive work surface to ESD ground resistance checks being performed per Table 2-4b?
36	-	Are the ESD protective conductive work surface to ESD ground resistance checks being performed per Table 2-4c?
37	-	Are the ESD protective floor to ESD ground resistance checks being performed per Table 2-4d?
38	-	Are the ESD protective floor surface point-to-point resistance checks being performed per Table 2-4e?
39	-	Are the continuous wrist strap monitor checks being performed per Table 2-4f?
40	-	Are the ESD ground continuity checks being performed per Table 2-4g?
41	-	Are the ionizer balance checks being performed per Table 2-5a?
42	-	Are the ionizer charge decay checks being performed per Table 2-5b?
43	-	Is an annual ESD system compliance check to the requirements of this standard being performed? (Table 2-6)
44	-	When compliance to the daily, weekly, quarterly, semiannual, and/or annual checks is not continuously maintained, are the checks performed more frequently? (Table 2-Note 1)
45	-	When the ESD protective item check frequency adjustment option is used, do the records show that the specified minimum continuous time without failures has been met before changing the frequency? (Table 3-1)
46	-	When the ESD protective item check frequency adjustment option is used, do the records show at least 30 checks in the item population before changing the frequency? (Table 3-1)
47	-	When the ESD protective item check frequency adjustment option is used, do the records show that the frequencies are not changed more than one level at a time? (Table 3-2)
48	-	When the ESD protective item check frequency adjustment option is used, do the records show that the frequencies have not changed more than two (2) levels from that specified in Table 2? (Table 3-2)
49	-	When the ESD protective item check frequency adjustment option is used, do the records show that one (1) failure within the item population moved the audit frequency back one (1) level? (Table 3-3)
50	-	When the ESD protective item check frequency adjustment option is used, do the records show that the daily and annual frequencies have not been reduced? (Table 3-4)

ESD AUDIT CHECKLIST

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
51	-	Are records of the Table 2 ESD item checks maintained for a minimum of one year? (6.2) NOTE: Continuously monitored items and visual checks do not require written records. (6.2)
52	-	Are compliant resistance, capacitance, and voltage measurements recorded using either variables (the measured values) or attributes (pass)? (6.2a)
53	-	Are noncompliant measurements recorded as variables (the measured values) when the measuring equipment is capable of providing variables or as attributes (fail) when the equipment is only providing attributes? (6.2.b)
54	-	Are the resistance paths of wrist straps, heel/toe straps and conductive shoes independently checked while being worn to the resistance limits of Table 2? (6.4)
55	-	Does the wrist strap resistance measurement path go from the wearer's hand, through the user's body, the body-to-strap contact, the integral resistor, the strap wire, to the strap ground connector? (6.4.1)
56	-	Is each heel/toe strap and conductive shoe resistance measurement path measured first from the user's hand, through the user's body, the body-to-strap/shoe contact, the strap/shoe to the conductive plate? (6.4.2)
57	-	When wrist strap monitoring equipment is used, are the corrective actions resulting from monitor alarms documented? (6.4.3) NOTE: Daily wrist strap checks and logs are not required when continuous wrist strap monitoring equipment is used. (6.4.3)
58	-	Is an electrostatic voltmeter used to verify that static voltages are compliant to the Table 2 limit? (6.5)
59	-	Are ESD caution signs posted to clearly indicate the ESD protected area boundaries and workstations to all approaching personnel? (6.6.1)
60	-	Do the ESD caution signs indicate by words and/or symbol that ESD HANDLING IS REQUIRED in the area and/or at the workstation? (6.6.1)
61	-	Does each ESD protective package have a contrasting ESD caution label? (6.6.2) NOTE: Single color labels in any color that contrasts with the background may be used. (6.6.2)
62	-	Are the ESD caution labels legible to normal vision at a distance of three feet? (6.6.2)
63	-	Does the ESD caution label clearly indicate by words and/or symbol that ESDS devices are inside the package and that the package cannot be opened except at a designated ESD handling area or station? (6.6.3)

ESD AUDIT CHECKLIST

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
64	-	For commercial devices, does each ESD protective package have an ESD caution label placed in a standard location to ensure that people will be aware that ESDS devices are inside the packages? (6.6.4)
		NOTE: The ESD caution label on the package may be provided by a preprinted marking on the package or its sealing tape. (6.6.4)
65	-	For military devices, does the ESD caution label and its position conform to the requirements of MIL-STD-129? (6.6.5)
66	-	Is equipment/earth ground used for ESD ground? (7.1)
67	-	When equipment grounds (the green wire) are used, have the receptacles been tested to and meet the requirements of NFPA-70? (7.1)
68	-	When both equipment and earth grounds are used at the same ESD protective workstation, are they bonded together at some point in the ground system? (7.1.1)
69	-	Have all equipment grounding receptacles and conductors been tested in accordance with NFPA-70 after being installed or modified and prior to being used? (7.1.2)
70	-	Does the design and construction of the grounded ESD protected workstation and associated equipment ensure that all external parts, surfaces, and shields of electrical equipment and power tools are at ground potential at all times? (7.3)
71	-	Is each ESD workstation individually connected to the ESD ground? (7.3)
72	-	When more than one ESD work surface is used at a workstation, is each surface individually connected to the ESD ground? (7.3)
73	-	When highly conductive ESD protective work surfaces are used (e.g., stainless steel), are they connected directly to ESD ground without a series resistor to ensure they are continuously at ground potential? (7.4.2)
74	-	When conductive ESD protective work surfaces are used, are they either connected directly to ESD ground or connected to ESD ground through an optional series resistor? (7.4.3)
75	-	When floor grounding devices (ESD protective footwear and/or mobile ESD protected workstations) are being utilized, are ESD protective flooring/mats used? (7.5)
76	-	When ESD protective flooring is used, is it connected directly to ESD ground without a series resistor? (7.5)
77	-	When ESD protective floor mats are used, are they connected to ESD ground directly or through an optional resistor? (7.5)
78	-	Are firm fitting connecting devices such as metallic crimps, snaps and banana plugs used for connections to the designated ESD ground points? (7.6)
79	-	Does shelving that is being used as an ESD protected area or workstation meet all of the requirements for an "ESD protected area or workstation" per 6. and Tables 1 and 2? (7.8)

ESD AUDIT CHECKLIST

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
80	-	When shelving is <u>NOT</u> an ESD protected area or workstation, are all ESDS devices in ESD protective packaging? (7.8)
81	-	Is mobile equipment (e.g., carts, chairs, tables) kept from generating electrostatic voltages greater than ± 200 volts within twelve (12) inches of unprotected ESDS devices during use? (7.9.1)
82	-	When mobile equipment is used as an ESD protected workstation (e.g., cart, table), is it connected to ESD ground? (7.9.2)
83	-	When mobile equipment is used as an ESD protected workstation (e.g., cart, table), does it meet the requirements for an ESD protected workstation per 4.12 and Table 1? (7.9.2)
84	-	When a floor grounding device (e.g., drag chain, drag wire, conductive castor) is used to ground mobile ESD protected workstations, is an ESD protective floor or mat used? (7.9.2)
85	-	Are all ESDS devices packed in ESD protective packaging per 4.13 when not at an ESD protected area or workstation? (8.1)
86	-	Are the packing and filler materials for ESDS devices free from triboelectric charges greater than ± 200 volts in normal/intended use? (8.2)
87	-	Do the antistatic (antistat solution treated) tubes, trays, magazines and carriers provide mechanical protection for devices and minimize triboelectric charging? (8.3)
88	-	When applying or removing static generating tapes and labels to antistatic tubes, magazines and carriers with ESDS devices inside, are the static voltages limited to $\leq \pm 200$ volts? (8.3)
89	-	When individual finished device carrier materials are insulative, do the handling methods minimize triboelectric charging of the carriers and surrounding materials such that static voltages on the carriers do not exceed ± 200 volts? (8.4)
90	-	Are ESDS wafers and die packed using materials that do not tribo-electric charge to greater than ± 200 volts under normal/intended use (antistatic per 4.2)? (8.5)
91	-	Are all ESDS devices shipped and received in closed ESD protective packages, which are not opened except at ESD protected workstations? (8.6)
92	-	Does each site have a designated ESD coordinator/team? (9.1)
93	-	Is the ESD coordinator/team responsible for assuring that the requirements of this standard are met? (9.1)
94	-	Do the ESD protective item check frequencies meet the requirements of Table 2 and, when the optional check frequency adjustment is used, Table 3? (9.2)
95	-	Is the optional ESD protective item check frequency adjustment procedure only used when consecutive ESD protective item check results meet the requirements of Table 3? (9.2)
96	-	Is an audit performed of each operation that processes, handles or stores ESDS devices at least once a year to verify compliance to all requirements of this standard using the ESD Audit Checklist or an equivalent checklist? (9.3)

ESD AUDIT CHECKLIST

ITEM	Y/N /NA	QUESTIONS (TEXT REFERENCE)
97	-	When noncompliance to the requirements of this standard are found, are both the noncompliance and their causes corrected? (9.4)
98	-	When noncompliance to the requirements of this standard are found, are both the noncompliance and corrective actions documented? (9.4)
99	-	When noncompliant ESD protected areas and/or workstations are found, is processing of ESDS devices through that area and/or workstation suspended until the noncompliance is corrected? (9.4.1)
100	-	Are ESDS devices that have <u>NOT</u> been continuously handled, packaged and transported according to this standard dispositioned per documented procedures? (9.4.2)
101	-	Are rejected (e.g., electrical, mechanical) ESDS devices that are being returned to suppliers, handled and shipped in accordance with the requirements of this standard? (9.4.3)
102	-	When the supplier's original packing materials and containers are noncompliant to this standard, are the ESDS devices rejected and returned in the original materials and containers? (9.4.3)
103	-	Are written records kept of all audits for at least two (2) years? (9.5)
104	-	Are written records kept of all inspection, measuring and test equipment calibrations for at least two (2) years? (9.5)
105	-	Do the audit records specify what was audited, the auditor's name, date of audit, audit results, corrective actions required (if applicable), and evidence of verification of satisfactory completion of any required corrective actions? (9.5)
106	-	Have all personnel handling ESDS devices received ESD handling training initially and at least every 12 months thereafter to maintain proficiency? (10)
107	-	Are training records maintained for each individual? (10.2)
108	-	As a minimum, do the records show the dates of training, length of training session, topics covered, and the name of the trainer? (10.2)
109	-	Are the training records maintained for at least two (2) complete years? (10.2)
110	-	Are static charge preventive actions utilized at ESD protected areas and workstations where static voltages greater than ± 200 volts <u>ARE</u> measured <u>AND</u> unprotected ESDS devices are within twelve (12) inches of the charged sources? (11)
111	-	When used, are the air ionizers positioned so that the devices at the static-free workstations are within the ionizer manufacturer's specified coverage area? (11.3a)
112	-	When used, are the air ionizers aimed at the devices and operator's hands rather than at the operator? (11.3a)
113	-	When used, are the ceiling air ionizers oriented in relation to the work surfaces in accordance with the ionizer manufacturer's instructions? (11.3b)

ESD AUDIT CHECKLIST

<u>ITEM</u>	<u>Y/N</u> <u>/NA</u>	<u>QUESTIONS (TEXT REFERENCE)</u>
114	-	When air ionizers are used, are the devices kept beyond the minimum distance specified by the ionizer manufacturer? (11.3c)
115	-	When used, do the air ionizers have an unrestricted, straight line air flow between the ionizers and the unprotected devices? (11.3d)
116	-	When air ionizers are used, is the ionizer balance (positive and negative ions) verified per Table 2? (11.3e)
117	-	When air ionizers are used, is the ionizer charge decay performance verified using the method described in EOS/ESD-S3.1 per Table 2? (11.3f)
118	-	When worn, are the ESD protective smocks buttoned (except for the collar) whenever the wearer is at an ESD protected workstation or in a designated ESD protected area? (11.4a)
119	-	When ESD protective smocks are worn, are the smocks with static voltages greater than ± 200 volts removed from service? (11.4c)
120	-	When gloves or finger cots are worn, are only cotton gloves, antistatic/conductive gloves, or antistatic/conductive finger cots used when handling ESDS devices? (11.5)