

ESD TR53-01-18

ESD Association Technical Report

ESD TR53-01-18
Revision of ESD TR53-01-15

*for the Protection of Electrostatic
Discharge Susceptible Items*

*Compliance Verification of ESD Protective
Equipment and Materials*



*Electrostatic Discharge Association
7900 Turin Road, Bldg. 3
Rome, NY 13440*

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FOREWORD

This technical report describes the test procedures and instrumentation that can be used to periodically verify the performance of ESD protective equipment and materials. After ESD protective equipment and materials are installed and in their actual use locations, these compliance verification test procedures are recommended to provide a baseline for comparison with future compliance verification tests. The objective of these test methods is to identify if significant performance changes in ESD equipment and materials have occurred over time and to verify the compliance of ESD protective items within the ESD Control Plan.

The wide variety of ESD protective equipment and materials, and the environment in which they are used may require test setups different from those described in this technical report. Users of this technical report may need to adapt the test procedure and setups (as required) to produce meaningful data for their own application. Organizations who perform these tests will also need to determine the time interval between compliance verification and sample size based on how critical the ESD protective equipment and materials are to their static control program.

All test procedures in this document are based on current standards, standard test methods, and standard practices currently published by the ESD Association.

This technical report was originally designated ESD TR53-01-06 and was published in 2006. ESD TR53-01-15 was a revision of ESD TR53-01-06 and was approved on February 6, 2013. ESD TR53-01-18 is a revision of ESD TR53-01-15 and was approved for publication on May 31, 2018.

At the time ESD TR53-01-18 was prepared, the 53.0 Compliance Verification subcommittee had the following members:

	Kevin Duncan, Chair Seagate Technology	
Nate Ashworth Julie Industries, Inc./StaticSmart Flooring	Mary Kay Botkins ACL Staticide, Inc.	Cheryl Checketts Estatec
David Girard Honeywell Aerospace	Ginger Hansel Dangelmayer Associates, LLC	John Kinnear, TAS Rep IBM
Charles McClain Micron Technology, Inc.	Rachel Reinstra Lockheed Martin	James Roberts Continental Automotive
Jeff Salisbury Finisar Corporation	Matt Strickland, Vice-Chair L-3 Communications	Wolfgang Stadler Intel Deutschland GmbH

The following individuals contributed to the development of ESD TR53-01-15 and/or ESD TR53-01-06:

Eugene Chase
Electro-Tech Systems, Inc.

Cheryl Checketts

Melissa Feeney-Jolliff
Aerospace Corp.

Gene Felder
Desco Industries, Inc.

Jay Hamlin
Medtronic

Timothy Jarrett
Boston Scientific

John Kinnear
IBM

Gregory Manning
NASA/ARES Technical
Services

Tom Pelc
Oracle

Tim Prass
Raytheon

Brian Retzlaff
Plexus Corporation

Bill Ricker
Ricker Engineering Services

Jeff Salisbury
Seagate Technology

Jose Sancho
NASA/GSFC/Honeywell TSI

Sarah Smith
Walker Forge

Fred Tenzer
Desco Industries, Inc.

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ESD Association Technical Report for the Protection of Electrostatic Discharge Susceptible Items – Compliance Verification of ESD Protective Equipment and Materials

1.0 PURPOSE

The purpose of this technical report is to provide compliance verification test procedures and troubleshooting guidance for ESD protective equipment and materials. Test results may be used for the compliance verification plan requirements of ANSI/ESD S20.20 or those of the user.

2.0 SCOPE

This document describes compliance verification testing for the following ESD Protective Equipment and Materials:

- Grounding / Bonding Systems
- Worksurfaces
- Wrist Straps
- Footwear
- Flooring
- Seating
- Air Ionizers
- Mobile Equipment
- Electrical Soldering/Desoldering Hand Tools
- Constant (Continuous) Monitors
- Garments
- Packaging
- Process Required Insulators
- Isolated Conductors

3.0 PERSONNEL SAFETY

THE PROCEDURES AND EQUIPMENT DESCRIBED IN THIS DOCUMENT MAY EXPOSE PERSONNEL TO HAZARDOUS ELECTRICAL CONDITIONS. USERS OF THIS DOCUMENT ARE RESPONSIBLE FOR SELECTING EQUIPMENT THAT COMPLIES WITH APPLICABLE LAWS, REGULATORY CODES AND BOTH EXTERNAL AND INTERNAL POLICY. USERS ARE CAUTIONED THAT THIS DOCUMENT CANNOT REPLACE OR SUPERSEDE ANY REQUIREMENTS FOR PERSONNEL SAFETY.

GROUND FAULT CIRCUIT INTERRUPTERS (GFCI) AND OTHER SAFETY PROTECTION SHOULD BE CONSIDERED WHEREVER PERSONNEL MIGHT COME INTO CONTACT WITH ELECTRICAL SOURCES.

ELECTRICAL HAZARD REDUCTION PRACTICES SHOULD BE EXERCISED AND PROPER GROUNDING INSTRUCTIONS FOR EQUIPMENT SHALL BE FOLLOWED.

THE RESISTANCE MEASUREMENTS OBTAINED THROUGH THE USE OF THIS TEST METHOD SHALL NOT BE USED TO DETERMINE THE RELATIVE SAFETY OF PERSONNEL EXPOSED TO HIGH AC OR DC VOLTAGES.

4.0 TEST EQUIPMENT

If user defined required limits are outside the specifications of the test equipment, the user should define test equipment that will measure their specific requirements. Test equipment should be used and calibrated according to the manufacturer's recommendations.

4.1 AC Outlet Analyzer

An AC outlet analyzer can be used to indicate the correct wiring of the equipment-grounding conductor. Please note that some AC outlet analyzers may not be able to differentiate ground and neutral wire reversals, hot and neutral wire reversals, and hot and ground wire reversals, or determine if the impedance to ground of the equipment-grounding conductor is within the company specification.

4.2 AC Circuit Tester (Impedance Meter)

The meter should be capable of measuring the impedance of the equipment-grounding conductor from a receptacle (power outlet used for establishing the AC equipment ground) to the neutral bond at the main service equipment panel. The meter should also verify wiring orientation.

4.3 Charged Plate Monitor (CPM)

4.3.1 A Charged Plate Monitor (CPM) as described in ANSI/ESD STM3.1, which consists of an ion collecting plate, a means to charge the ion collecting plate, a means to monitor the ion collecting plate voltage and a timer to measure discharge time. The conductive plate shall be 152 mm by 152 mm (6 inches by 6 inches), and the total capacitance of the test circuit, with plate, while the instrument is in its normal operating mode, shall be $20 \text{ pF} \pm 2 \text{ pF}$.

4.3.2 A portable verification kit (as described in ANSI/ESD SP3.3) may be used for the compliance verification of air ionizers. Portable verification kits are commercially available and typically consist of four components: 1) electrostatic field meter, 2) detachable (isolated conductive) plate, 3) plate charger, and 4) ground cord.

4.4 Concentric Ring Electrode Assembly

The electrode assembly consists of two concentric rings made of conductive materials that make contact with the material under test.

The contact surface material of the electrode assembly shall be a conductive material having a hardness of 50 to 70 on the Shore-A Durometer scale.

The conductive material shall have a volume resistivity of less than 10 ohm-cm.

The inner electrode shall be a solid disk, $30.48 \pm 0.64 \text{ mm}$ ($1.2 \pm 0.025 \text{ inches}$) in diameter.

The outer electrode shall be a ring having an inner diameter of $57.15 \pm 0.64 \text{ mm}$ ($2.25 \pm 0.025 \text{ inches}$). The width of the outer ring shall be $3.18 \pm 0.254 \text{ mm}$ ($0.125 \pm 0.010 \text{ inches}$).

The total weight of the complete electrode assembly shall be $2.27 \text{ kg} \pm 56.7 \text{ grams}$ ($5 \text{ pounds} \pm 2 \text{ ounces}$).

The electrode assembly described in ANSI/ESD STM11.11 meets these specifications.

4.5 DC Ohmmeter

The meter should be capable of measuring a D.C. resistance of 0.1 ohm through 1.0 megohm (or other added resistance value) with an accuracy of $\pm 10\%$ of the value being measured.

4.6 Electrostatic Field Meter

A non-contacting sensing instrument used to measure the electric field that results from the static charge on a material. The meter shall be capable of measuring from 0 to $\pm 2000 \text{ volts/inch}$ ($78,740 \text{ volts/meter}$) or greater.

4.7 Non-contact Electrostatic Voltmeter

A non-contacting sensing instrument used to measure the surface potential that results from the static charge on a material. The meter shall be capable of measuring from 0 to ± 2000 volts or greater.

4.8 Foot Electrode

A conductive metal plate that is at least 305 mm x 305 mm (12 inches x 12 inches).

4.9 Hand-Held Electrode

A stainless steel, brass or copper round or tubular stock, approximately 2.5 cm (1 inch) in diameter x 7.5 cm (3 inches) or greater in length, with a banana plug receptacle or screw connector attached to one end of the cylinder. All dimensions are nominal.

4.10 High Impedance Contact Electrostatic Voltmeter

A contact sensing instrument with a measurement range of at least 0 to ± 35 volts DC or AC peak, a measurement accuracy of less than $\pm 1\%$ and an input capacitance less than 1.0×10^{-13} farads with an input impedance greater than 1.0×10^{14} ohms.

4.11 Insulative Support Surface

A planar (flat) surface, when used for specimen support, shall have a surface resistivity greater than 1.0×10^{13} ohms/square when measured per ASTM D257 or a surface resistance greater than 1.0×10^{12} ohms when measured per ANSI/ESD STM11.11.

For test methods using 2.27 kg (5 pounds), 6.35 cm (2.5 inches) electrodes, an alternate method to verify the properties of the insulative support surface may be used by measuring the resistance point-to-point of the material with the electrodes spaced at least 15 cm (6 inches) apart (edge-to-edge). A resistance point-to-point of at least one order of magnitude greater than the upper limit of the item being measured is required.

4.12 Integrated Checker

A purpose-built instrument intended to indicate a specific resistance parameter that is capable of measuring from 1.0×10^4 ohms to at least 1.0×10^{11} ohms.

4.13 Resistance Measurement Apparatus

A meter that is capable of making measurements or making indications from 1.0×10^a ohms to 1.0×10^b ohms. Typically the measurements will be made at 10 volts or 100 volts but instruments with other voltages may be used if correlated to the product qualification meter or laboratory meter before use.

(NOTE: "a" should be one order of magnitude below the lowest measurement and "b" should be one order of magnitude above the highest measurement.)

4.14 Resistance Measurement Electrode(s)

Cylindrical electrode, 2.27 kg $\pm 2.5\%$ (5 pounds $\pm 2.5\%$) with a diameter of 63.5 mm $\pm 5\%$ (2.5 inches $\pm 5\%$) having a contact of electrically conductive material with a Shore-A (IRHD) durometer hardness between 50 and 70. The resistance between two electrodes should be less than 1.0×10^3 ohms when measured at 10 volts on a metallic surface.

The electrode described in ANSI/ESD STM4.1 meets these specifications.

NOTE: Over time, conductive rubber materials used as the contact surface of the probes can warp. This could cause measurements to change. At this time there is no standardized method to verify if this has occurred but the user should be aware of this phenomenon.

4.15 Two-Point Probe

A two-point probe consists of an insulated metal body with a Teflon[®] insulator inserted into each end. One insulator holds test leads; the other holds receptacles that accept spring-loaded pins. One receptacle is surrounded by a cylindrical insulator, which is surrounded by a metal shield. The pins are gold plated and have a spring force of 0.465 kg (16.4 oz.) $\pm 10\%$ at a travel of 4.32 mm (0.170 inches). The pin tips are machined to accept friction fitted 3.18 mm (0.125 inches) diameter electrically conductive rubber electrodes. The rubber has a Shore-A (IRHD) durometer hardness of 50-70 (ASTM Method D2240). The electrodes are 3.18 mm (0.125 inches) long. Electrode volume resistivity is < 500 ohm-cm.

The two-point probe described in ANSI/ESD STM11.13 meets these specifications.

5.0 GROUNDING / BONDING SYSTEMS

This compliance verification test procedure is in part based on the following publication(s):

ANSI/ESD S6.1, Grounding

ANSI/NFPA 70, National Electric Code

5.1 Objective

The objective of this compliance verification test procedure is to verify that the various grounding/bonding systems of an ESD protective workstation (and/or ESD protected area) are within the maximum resistance value allowed by the user's specification.

A properly configured ESD protective workstation will have all ESD worksurfaces, fixtures, handling equipment and personnel grounding devices connected to a common point ground. The common point ground is connected to the ESD grounding / bonding reference point, which in most cases will be the AC equipment ground. If an auxiliary ground is used, it should be electrically bonded to the AC equipment ground (see ANSI/ESD S6.1 for details).

5.2 Test Equipment

Reference Section 4.0 – Test Equipment in the beginning of this document.

- DC Ohmmeter
- AC Outlet Analyzer
- AC Circuit Tester (Impedance Meter)
- Two test leads of sufficient length

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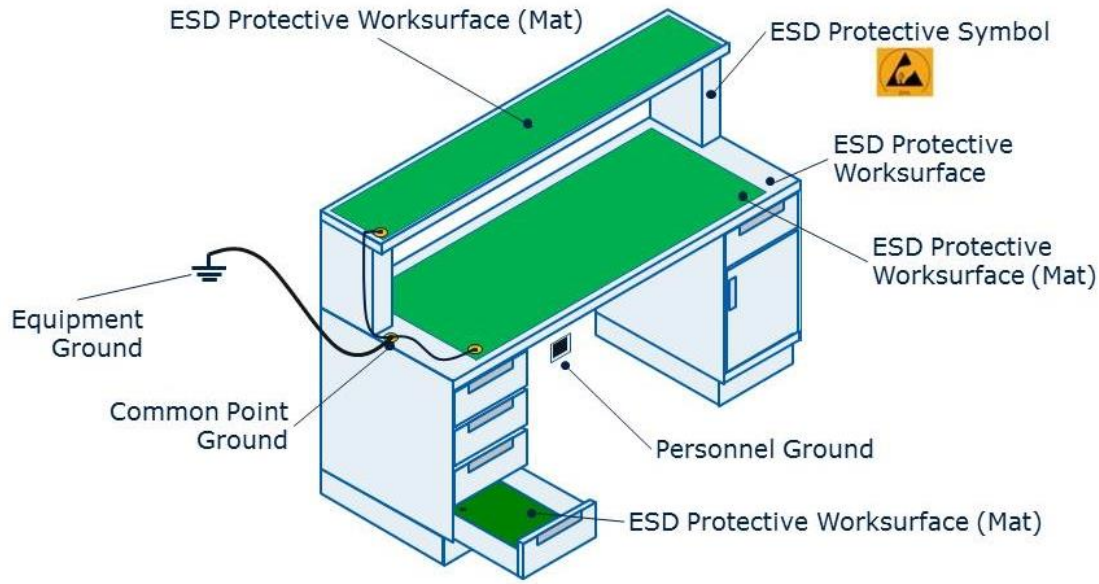


Figure 1: ESD Protective Workstation

5.3 Test Procedure

5.3.1 Electrical Receptacles

Grounding procedures must remain consistent with the National Electric Code (NEC) and other applicable codes. The receptacle wiring verification test is intended to check for the proper wiring of the equipment grounding conductor that is used as the ESD grounding / bonding reference point.

An AC outlet analyzer can be used to indicate the correct wiring of the equipment-grounding conductor. Please note that some AC outlet analyzers may not be able to differentiate ground and neutral wire reversals, hot and neutral wire reversals, and hot and ground wire reversals, or determine if the impedance to ground of the equipment-grounding conductor is within the company specification.

An AC circuit tester can be used to verify the integrity of the electrical circuit wiring as needed.

5.3.1.1 Connect the AC circuit tester (impedance meter) to the AC outlet or receptacle containing the equipment grounding conductor that will be used for the ESD grounding / bonding reference point.

5.3.1.2 Verify the following conditions:

- Neutral and equipment grounding conductor wires are present and not connected to each other at the receptacle (outlet).
- Hot and neutral wires are not reversed.
- Hot and equipment-grounding conductors are not reversed.
- Impedance of the equipment-grounding conductor is within the maximum resistance value allowed by the user's specification.

5.3.2 Personnel Groundable Points

5.3.2.1 Operate the DC ohmmeter according to the manufacturer's instructions.

5.3.2.2 Connect two test leads to the DC ohmmeter.

5.3.2.3 Connect or place one test lead to the personnel groundable point (personnel ground) and the other test lead to the ground reference.

5.3.2.4 Note the resistance.

5.4 Troubleshooting

5.4.1 Electrical Receptacle Failures

Any AC outlet or directly connected equipment (hard wire) that fails the receptacle wiring verification tests must be corrected by qualified personnel before further use or testing.

5.4.2 Personnel Groundable Point Failures

- Visually and mechanically confirm that all termination hardware and grounding wires are not inadvertently loose, broken, or disconnected.
- Test the resistance of the personnel groundable point to common point ground.
- Test the resistance of the common point ground to AC Grounding/Bonding Reference Point.

Defective ESD equipment and materials that cannot be brought into compliance should be taken out of service.

6.0 WORKSURFACES

This compliance verification test procedure is in part based on the following publication(s):

ESD ADV53.1, ESD Protective Workstations

ANSI/ESD STM4.1, Worksurfaces – Resistance Measurements

ANSI/ESD S6.1, Grounding

6.1 Objective

The objective of this compliance verification test procedure is to verify that the ESD worksurface is electrically bonded to the ground reference and is within the minimum and maximum resistance allowed by the user's specification.

This periodic test procedure can also be used for the measurement of shelves, drawers and other grounded ESD protective storage equipment surfaces.

6.2 Test Equipment

Reference Section 4.0 – Test Equipment in the beginning of this document.

- An integrated checker or meter, whether it is a single meter or a collection of instruments that are capable of measuring at least 1.0×10^{10} ohms with a test voltage of 10 and 100 volts ($\pm 10\%$) DC open circuit or under load.
- One resistance measurement electrode
- Two test leads of sufficient length
- DC Ohmmeter

6.3 Test Procedure

6.3.1 Do not clean the ESD worksurface immediately prior to verification.

6.3.2 Remove all ESD sensitive items from the ESD worksurface.

6.3.3 Conductive items and AC-powered equipment that are part of the workstation and have separate paths to the ground reference should remain connected to their grounds as the ESD worksurface is being verified.

6.3.4 Connect one end of the first test lead to the resistance measurement electrode, and the other end of the first test lead to the integrated checker or meter.

6.3.5 Connect one end of the second test lead also to the integrated checker or meter, and the other end of the second test lead to ground reference.

6.3.6 Place the resistance measurement electrode in the center of the ESD worksurface.

6.3.7 Apply 10 volts and wait 5 seconds, or for the integrated checker or meter to stabilize. If the indicated resistance is less than 1.0×10^6 ohms, note the resistance. If the indicated resistance is equal to or greater than 1.0×10^6 ohms, switch the integrated checker or meter to 100 volts and retest. Note the resistance after the integrated checker or meter stabilizes or after 15 seconds.

NOTE: Switching the test voltage to 100 volts may result in a resistance reading of less than 1.0×10^6 ohms. When this occurs the reading made with the 100 volt test voltage is used.

6.3.8 Tests should include those ESD worksurface areas that are subject to wear or are visibly dirty.

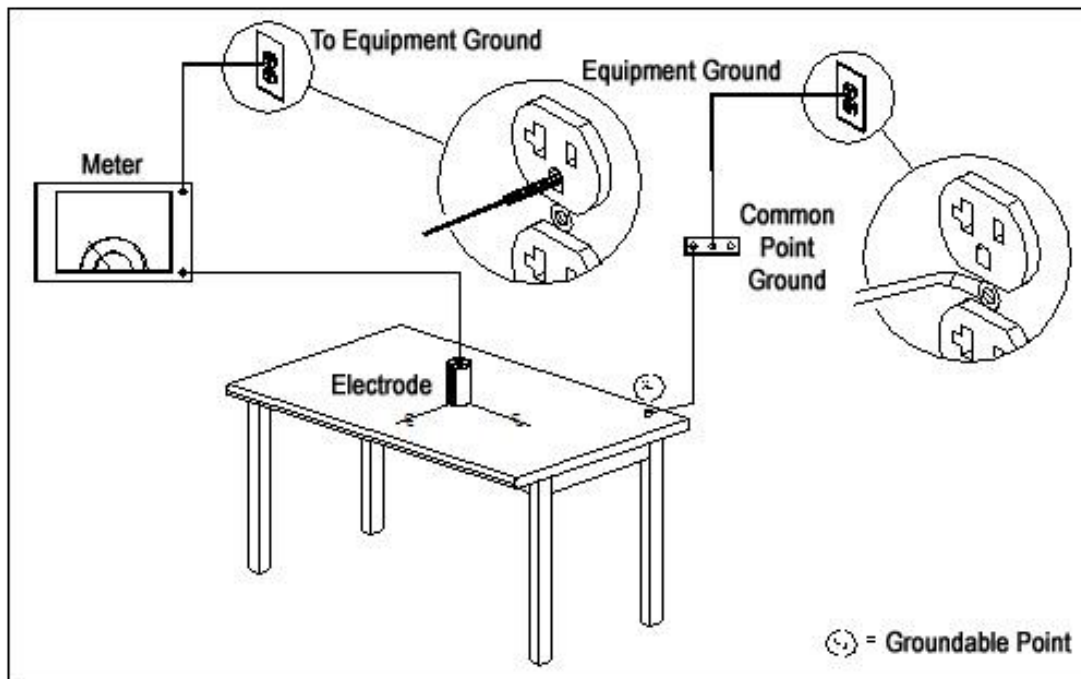


Figure 2: ESD Worksurface Test

6.4 Troubleshooting

6.4.1 Visual / Mechanical Check

- Visually and mechanically confirm that all termination hardware and grounding wires are not loose, broken, or disconnected.