



IPC-TM-650 TEST METHODS MANUAL

1 Scope EOS and electrostatic discharge (ESD) have been proven to damage and degrade electronic components and assemblies. This test method consists of a series of individual test procedures to test soldering and desoldering hand tools with grounded working surfaces for electrical grounds, transient voltages, and current leakage.

This series of test methods attempts to identify those bench-top systems, which might contribute to premature assembly failure from EOS/ESD related failure mechanisms. Test results may be erroneous or skewed if they are incorrectly performed, influenced by outside forces (e.g., air conditioning discharge over the unit under test), or if incorrect test equipment is selected.

Test equipment selected for equipment qualification must be capable of measuring the low voltages and current emitted by the unit under test (UUT). Additionally, the equipment must be capable of reading pulses and frequencies emitted by the UUT, which may be oscillator or microprocessor controlled. As faster and more capable oscillator and microprocessor controlled equipment is introduced by equipment manufacturers, it may become necessary to select test equipment with a broader bandwidth than that currently specified in this procedure. Failure to do so is likely to qualify equipment that might otherwise be disqualified.

Several of these tests can be falsely influenced by radio frequency interference and electromagnetic interference from lighting and equipment found in the workplace and testing area. To avoid these influences the leakage and transient tests should be performed in a screen room. In lieu of a screen room, a separate test procedure (see Test Method 2.5.33.4) has been provided to make a low cost shielded enclosure which should provide adequate shielding for the performance of these test procedures.

Warning: These are laboratory test procedures that may of necessity expose terminals that carry line voltages. All standard laboratory safety procedures regarding the setup and performance of tests with line voltage equipment must be observed at all times.

Caution: These tests are performed with soldering systems at their normal operating temperature. Test personnel must take adequate precautionary steps to protect themselves and others from potential burns.

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Subject Measurement of Electrical Overstress from Soldering Hand Tools	
Date 11/98	Revision
Originating Task Group Manual Soldering Task Group (5-22c)	

1.1 Purpose The purpose of the electrical overstress (EOS) test methods is to provide standardized test procedures for the qualification of equipment to Appendix A of ANSI/J-STD-001. Users may utilize Appendix A as part of an equipment qualification procedure or may be referred to Appendix A when the process has been determined to be out of control (see ANSI/J-STD-001).

2 Applicable Documents.

ANSI/J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies

IPC-TM-650 Test Methods Manual

- 2.5.33.1 Measurement of Electrical Overstress of Hand Soldering Tools - Ground Measurements
- 2.5.33.2 Measurement of Electrical Overstress of Hand Soldering Tools - Transient Measurements
- 2.5.33.3 Measurement of Electrical Overstress of Hand Soldering Tools - Current Leakage Measurements
- 2.5.33.4 Measurement of Electrical Overstress of Hand Soldering Tools - Shielded Enclosure

3 Test Specimens The tests that make up this test method call for the use of a locally produced sacrificial test electrode. The test electrode shall be a piece of single or double-sided 69 μm (15 mm thick) copper clad FR-4. The electrode size shall be of a uniform size 45 mm x 23 mm \pm 6.4 mm. The size may be adjusted to accommodate any locally produced test fixtures.

The size of the electrode area is designed so that it is not so big that it cools the temperature of the UUT below solder melt and not so small that the temperature of the UUT causes rapid oxidation or solder slugging. This electrode is designed to be replaceable since it will deteriorate after repeated testing.

4 Equipment/Apparatus The apparatuses utilized by the procedures that make up this test method are given in 4.1 through 4.19.

4.1 Test Electrode (see Section 3)

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4.2 AC millivoltmeter capable of measuring true mvAC/rms having a resolution of 0.1 mv AC. The frequency response of the millivoltmeter shall be 20 Hz-to-20 Mhz. (MilliVac MV814A, Hewlett-Packard HP3400B, or equivalent).

4.3 DC millivoltmeter capable of measuring at least 60 mv DC and having a resolution of 1 mv DC

4.4 Ohmmeter with a digital readout unit. It shall possess scales that can measure resistances beyond 5 M Ω with an accuracy of \pm 100 K Ω or better (\pm 10% or better of the lower limit). The ohmmeter shall have a resolution of 0.1 M Ω or better.

4.5 Storage oscilloscope, 100 Mhz bandwidth or faster, 1 M Ω input vertical amplifier

4.6 Oscilloscope probe - X10 Attenuation

4.7 Constant current Source capable of providing 10 milli-amps DC

4.8 Resistor, 4.99 Ω , 1% precision $\frac{1}{4}$ w or greater (any commercially available brand carbon or metal film)

4.9 Power line filter, 20 ampere @ 115 VAC, 50 dB insertion loss @ 5 Mhz/50 Ω

4.10 Test box (see 5.1)

4.11 Screen room/shielded enclosure (optional) capable of accommodating the entire UUT, cord, and hand piece. A filtered AC power receptacle shall be available from within (see Method 2.5.33.4).

4.12 Resistor, 1.00 K Ω , 1% (any commercially available brand carbon or metal film)

4.13 Diodes (two), which shall be of the lowest practicable known forward bias devices. 1N34 diodes have been found satisfactory for this purpose.

4.14 AC Receptacles (two)

4.15 Line cord

4.16 Strain relief

4.17 BNC Connector

4.18 Edge card connector w/mounting hardware

4.19 Metal (bud) box

5 Procedure All the following test procedures should be completed to ensure compliance with ANSI/J-STD-001:

Method 2.5.33.1 Measurement of Electrical Overstress from Soldering Hand Tools—Ground Measurements

Method 2.5.33.2 Measurement of Electrical Overstress from Soldering Hand Tools—Transient Measurements

Method 2.5.33.3 Measurement of Electrical Overstress from Soldering Hand Tools—Current Leakage Measurements

To construct a bench top shielded enclosure for use in lieu of a screen room, refer to:

Method 2.5.33.4 Measurement of Electrical Overstress from Soldering Hand Tools—Shielded Enclosure

5.1 Test Box Testing has shown that for UUTs that utilize high frequency circuits, layout and cord positioning can influence the AC current leakage reading. A compact configuration such as the one shown in Figure 1 minimizes those influences (see Method 2.5.33.3).

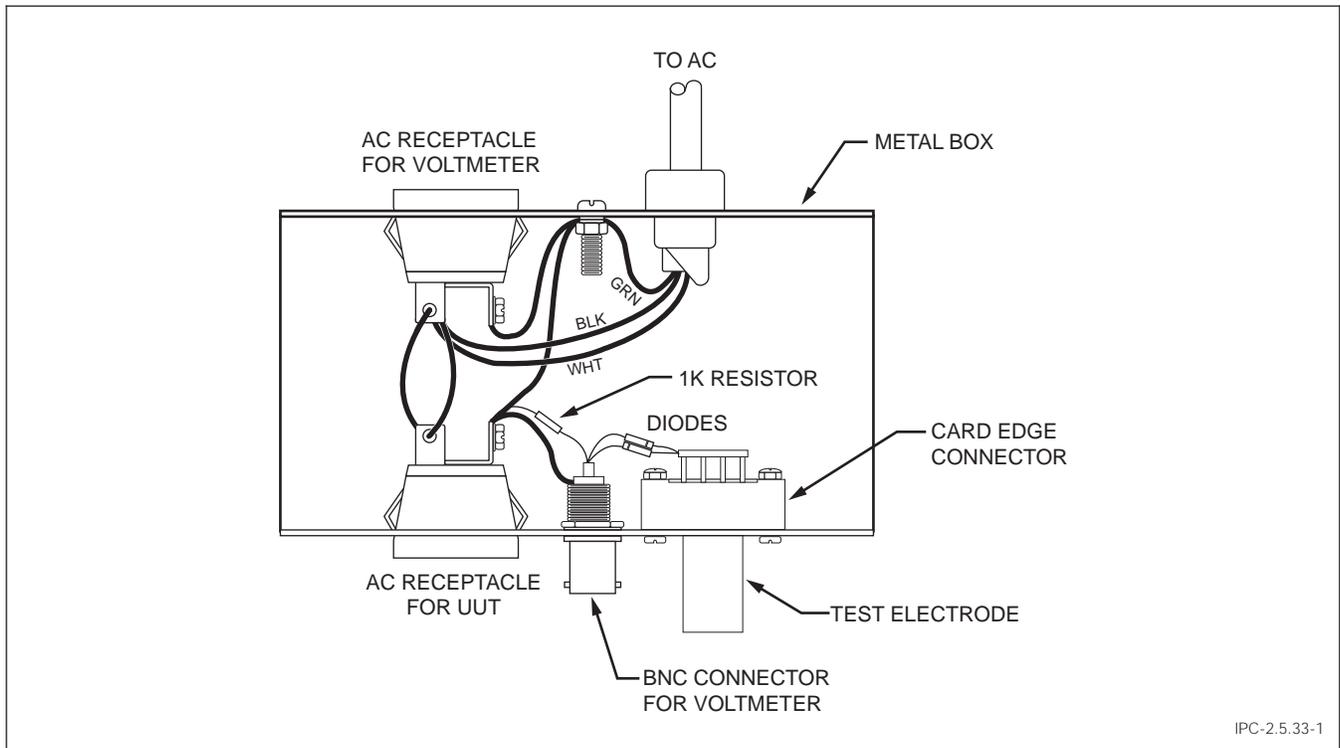
6 Notes

6.1 Pass/Fail Limits for Transients and Steady-State Voltage EOS/ESD papers typically discuss possible damage to electronic components coming from electrostatic discharge (ESD). The potentials discussed typically are 100's and 1000's of volts. This test method is also concerned with the possible damage to electronic components coming from electrical overstress (EOS). The EOS potentials of concern will be 1's of volts down to millivolts. This test method strives to set achievable EOS limits for soldering/desoldering equipment based upon the ability to construct soldering equipment as well as resolve small potentials from background interference.

Although any electronic component can be damaged by sufficient amounts of EOS/ESD, conventional wisdom states that semiconductors are the most susceptible. Two obvious EOS/ESD caused failure modes in semiconductors are:

- Dielectric breakdown or reverse voltage breakdown due to excessive potential

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Figure 1 Current Leakage Test Circuit Configuration

- Junction overheated due to excessive forward current

6.2 Limits to Prevent Voltage Breakdown Due to Individual Transients As integrated circuit geometries shrink, dielectric breakdown voltage ratings also diminish. One semiconductor discussed here (battery operated integrated circuits) currently represents the lowest breakdown ratings. S-MOS Systems' SMC62L35 single-chip microcomputer is designed to run from a single 1.5 volt battery. It has an absolute maximum voltage (damage could result) of 2 volts.

The recommended limit for individual transients is 2 volts peak.

6.3 Limits to Prevent Overheating Due to Steady-State Leakage Most semiconductor junctions are intentionally designed, but in integrated circuits, there are also unavoidable intrinsic junctions. Also, there are junctions that are never supposed to be operated in the forward direction (i.e., JFETs and tuning diodes). The devices are not well characterized by the

manufacturer regarding the maximum forward current. Regardless of the nature of the junction, simultaneous forward current and voltage drop results in power dissipation. If the junction power results in a sufficient temperature increase, the junction may be changed or destroyed. It is possible to prevent forward current from flowing through a junction simply by keeping the applied voltage below the forward junction voltage rating. Two semiconductors discussed here represent the lowest forward junction voltage ratings: Schottky diodes and germanium diodes. Motorola's MBD201 Schottky diode and most common germanium diodes begin to conduct at 220 millivolts. The test method apparatus represents these by including commonly available 1N34 germanium diodes. To be sure no junction heating can be caused by the UUT, the current should be zero. But practically, since zero is difficult to measure, a 1 microamp maximum tolerance can be permitted without fear of overheating the junction. The recommended limit for current leakage is 1 microamp (flowing through a closed circuit, which includes parallel head-to-tail germanium diodes).

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6.4 Test Results Complete ALL shaded areas.

Description of UUT (brand, model configuration, etc.):

Test	Procedure	Pass/Fail Criteria	Value Recorded	Status	
Ground Measurements	(2.5.33.1)	$\leq 5 \Omega$	Ω	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail
Transient Measurements/Pass 1	(2.5.33.2)	$\leq 2 \text{ V peak}$	V	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail
Transient Measurements/Pass 2	(2.5.33.2)	$\leq 2 \text{ V peak}$	V	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail
Transient Measurements/Pass 3	(2.5.33.2)	$\leq 2 \text{ V peak}$	V	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail
Current Leakage Measurements	(2.5.33.3)	$\leq 1.0 \mu\text{-amp DC}$	$\mu\text{-amp DC}$	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail
Current Leakage Measurements	(2.5.33.3)	$\leq 1.0 \mu\text{-amp ACrms}$	$\mu\text{-amp ACrms}$	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail

Description of Test Equipment and Configuration

Equipment	Function	Brand	Model	Calibration Date
AC millivoltmeter	true mvAC/rms			
DC millivoltmeter	60 mv DC			
Ohmmeter	resistances beyond 5 M Ω			
Storage Oscilloscope	100 Mhz bandwidth or faster, 1 M Ω input vertical amplifier			
Constant Current Source	10 milliamps DC			

Equipment	Scale Used	Cal / Std Meas.	Baseline Meas.
AC millivoltmeter			
DC millivoltmeter			
Ohmmeter			
Storage Oscilloscope			
Constant Current Source			

Additional Comments:

Test Completed by:

NAME:	DATE:
COMPANY:	PHONE:

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6.5 Reference

MIL-STD-1686¹ Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

MIL-HDBK-263 Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

EOS/ESD-S6.0-1994² Grounding - Recommended Practice

1. Standardization Documents Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094
 2. ESD Association, 7902 Turin Rd., Ste. 4, Rome, NY 13440-2069