



SEMI E43-95

RECOMMENDED PRACTICE FOR MEASURING STATIC CHARGE ON OBJECTS AND SURFACES

1 Purpose

The purpose of this recommended practice is to establish a guide for reproducible measurement of electrostatic charge(s) on any surface or object, consistent with the scope and limitations set forth below.

2 Scope

The measurement method described herein can be applied to characterize the general electrostatic charge level(s) on objects and surfaces in all environments. Acceptable instrumentation, calibration, and measurement techniques are described in this document. Appendices include background information on the equipment specified and calibration procedure, as well as information and advice on performing a useful general static survey.

3 Limitations

This SEMI document does not describe instrumentation and techniques capable of making highly precise measurement of electrostatic charge. It is not suitable for measurement of electrostatic charge on small objects, such as packaged devices (i.e., reading(s) obtained are indicative/general area and not precise/minute). No methods of preconditioning the surface prior to measurements and no methods of characterizing the basic electrostatic performance of materials, such as tribocharging, resistance, and decay rate are a part of this document. Measurements made using this practice on the same surface or object may differ due to differences in the environment or history of the surface or object between the times any two measurements are made.

4 Referenced Documents

4.1 ESD Documents

ESD Association Advisory for Electrostatic Discharge Terminology — Glossary, 1992

ESD Association Handbook

Note: The referenced documents are of related value and are for information only; in the case of conflict, this document takes precedence. Also read/be aware of appendices to this document before use.

5 Terminology

5.1 *electrostatic discharge (ESD)* — The rapid spontaneous transfer of electrostatic charge induced by a high electrostatic field.

5.2 *ground* — A conducting connection between an object, electrical equipment, and earth, such as the portion of an electrical circuit of the same electrical potential as earth.

5.3 *grounded* — Connected to earth or some other conducting body that serves in the place of earth.

6 Safety

6.1 *Measurements of Very High Static Potentials (> 30,000 Volts)* — Measurements of very high static potentials (> 30,000 V) may need to be done at larger distances to avoid exceeding the measurement range of the meter and/or an ESD event to the meter.

6.2 *Measurements on Moving Objects or Surfaces* — Care should be taken, when attempting to read electrostatic charges on moving objects or surfaces, to maintain correct distance and avoid any contact; this is to assure "good" readings with no mechanical damage or personal injury.

7 Requirements

7.1 Equipment

7.1.1 *Electrostatic Locator/Field Sensor/Field Meter* — The electrostatic locator/field sensor/field meter will henceforth be referred to as "the meter." Note that for measurements to be taken in the presence of air ionization, a chopper stabilized field meter is required. The meter must be capable of making field measurements at a distance of 2.54 centimeters (cm) = 1 inch or less, from the field source to the sensor for this document, as written. However, see Section 7.2.5 for meters that are operated at fixed distance(s), and adjust values in this document where applicable.

7.1.2 *Charged Plate Monitor* — A charged plate monitor or an electrically isolated 15.24 cm × 15.24 cm (6 inches × 6 inches) metal plate, henceforth referred to as "the plate." Provision for charging the



plate to (approximately, 1,000 volts, and 5,000 volts) high-low scale and/or expected values.

7.2 Equipment Calibration

7.2.1 Choosing Calibration Voltage(s) — Choose one or more calibration voltage(s) from the following table based upon the electrostatic field level of concern:

Field of Concern	Calibration Voltage
Under 4,000 volts/meter or 100 volts/2.5 cm	100 volts
Under 40,000 volts/meter or 1000 volts/2.5 cm	1,000 volts
Over 200,000 volts/meter or 5,000 volts/2.5 cm*	5,000 volts

* If meter calibration is needed above 5,000 volts, it is left to the user to select values using the table as guide.

7.2.2 Charging the Plate — Charge the plate to the calibration voltage you desire; refer to the manufacturer's manual on maintaining charge on plate.

7.2.3 Assuring Meter and Operator Are Grounded — Assure that the meter and operator are grounded. Turn on the meter and zero it as required according to manufacturer's instructions.

7.2.4 Directing or Pointing the Sense Head — Direct or point the sense head of the meter at the center and parallel to the surface of the plate at a distance of several inches. Slowly move the sense head toward the center of the charged plate until a reading equal to the voltage applied to the plate in 7.2.1 above is displayed by the meter. Measure and record the distance from the sense head to the surface to the plate. Using the plate voltage from 7.2.1 above and the recorded distance, compute the field strength. See Figure 1, Meter Calibration Check.

7.2.5 Alternative to Section 7.2.4 — Take measurements at a specified/fixed distance per manufacturer's instructions. Locate the sense head of the meter as in 7.2.4, but, at specified distance; reading displayed (on meter) should be within 5% of applied voltage to plate.

Note: Section 7.2.4 or 7.2.5 should be applicable to most meters. However, in every case, the electrostatic field meters manufacturer's instructions should be read, understood, and followed.

7.2.6 Other Desired Calibration Voltages — Repeat 7.2.2 and 7.2.5 for any other desired calibration voltages.

7.2.7 Meter Stability — Leave the meter on and wait approximately 15 seconds. Check the zero on the meter as specified by the manufacturer. If the zero of the meter has drifted by more than 5% of the calibration voltage, the meter is not suitable for use to this specification at that voltage. It may be suitable for use at other calibration voltages. Rezero the meter.

See Related Information 1 for notes on equipment accuracy and limitations.

8 Sampling

Sampling methods for this practice should be determined by the requirements of the user's application. Electrostatic surveys can be repeated at different times to make them more representative of actual static charge conditions in the surveyed area. The results will vary due to environment (e.g., humidity) and workstation setup/conditions. However, any measurement that is in excess of a (user) defined maximum or that is a benchmark value, should be repeated more than once, after performing a zero check of the meter. This is to validate previous reading(s) and/or establish a range/bounds in the case of varying-moving fields on previous reading(s).

9 Test Methods & Measurements

9.1 General Surveys of Electrostatic Voltage Fields

9.1.1 Calibrating the Meter — Calibrate the meter as in Section 7 above. Check/reset the zero periodically and/or per manufacturer's instructions. Assure that the meter and operator are grounded.

9.1.2 Measurements — Measurements made to this SEMI document should be taken/reported in units that conform to the customer specifications. Most common meters manufactured to date have operating instructions that reflect the user doing calibration and taking measurements in English units of volts/inch or volts at a fixed distance in inch(es) and in these cases, raw data are reported/listed directly. The international community specifies that units shall be in SI (Standard International) Metric units and the SI conversion factor in Section 7.1.1 will apply. However, by definition, electric field is expressed in volts per meter, and thus would be expressed according to the following table:



Calibration Voltage	For Readings of	Express in Multiples of	For Readings of	Express as
100 V	< 4,000 V/m	400 V/m	> 4,000 V/m	> 4,000 V/m
1,000 V	< 40,000 V/m	4,000 V/m	> 40,000 V/m	> 40,000 V/m
5,000 V	< 1.6×10^6 V/m	200,000 V/m	> 1.6×10^6 V/m	multiples of 200,000 V/m

Note: Measurements above 1000 volts/2.54 cm may be made based on calibration of the meter at 1000 volts where less precision is acceptable due to safety concerns with calibration equipment/setup or availability of such equipment.

For instance, when using a meter calibrated only at 100 volts, measurements under 4,000 volts/m would be expressed to the nearest 400 volts/m. Measurements over 4,000 volts/m would be expressed as > 4,000 volts/m. For a meter calibrated to all three voltages, measurements under 4,000 volts/m would be expressed to the nearest 400 volts/m, measurements between 4,000 and 40,000 volts/m would be expressed to the nearest 4,000 volts/m, and measurements over 40,000 volts/m would be expressed to the nearest 40,000 volts/m.

9.1.3 Measurement Limitations — Measurements made to this SEMI document are only valid for surfaces that are flat to a radius of 1.5 times the measurement distance from a point directly below the sensor head. For surfaces that are not flat, measurements should be made by moving the sensor over the surface such that the specified measurement distance is maintained as closely as possible. These measurements may only be stated as a range, with rounding as applicable to the meter's range of calibration according to 9.1.2. See Figure 2, Example Survey Boat of Semiconductor Wafers.

See Related Information 2 for notes on test methods environment and measurements.

10 Certification

Certification to survey areas to this practice is for the person doing the certification (certifier) to assure that the person being certified (certifyee) can calibrate the meter and make acceptable measurement of known static field(s) per Section 7 and applicable example(s) per Section 9. The certifier shall be someone qualified by education and/or training to calibrate and make measurements with the equipment called out in this document or someone previously certified.

10.1 Demonstrating Ability to Calibrate Meter Against Known Source — The certifyee shall charge the calibration plate, zero the meter, and perform the measurement a minimum of two times per Section 7;

record values per Section 11. Readings obtained shall be within 5% of expected values.

10.2 Demonstrating Ability to Measure Example Item(s) Acceptably — The certifier will have charged/uncharged example(s) of items/objects for measurement of static field(s) by certifyee(s) a minimum of two times per Section 9; record values per Section 11.

10.3 Certifying — Readings obtained per Section 10.2 shall be within 12% of expected values and methodology of obtaining readings shall be acceptable per certifier observation(s). A permanent record of certification is realized by certifyee when certifier signs record sheet(s) for file in personnel records and/or when certifier issues a certificate.

11 Documentation

Meter calibration check(s), benchmark or laboratory measurements, items/areas surveys, and/or any other electrostatic field measurements should be recorded in permanent records. Recorded are initial reading, second/validation reading, and any subsequent readings taken to acceptable range/bound levels observed. Record sheet(s) should show meter used, area (name), location, date, and items listed opposite readings, name of person who took readings, and space for comments.