*ANSI/ESD STM11.13-2004*

ESD association standard test method

*ANSI/ESD STM11.13-2004*

*For the Protection of Electrostatic Discharge Susceptible Items*

# *Two-Point Resistance Measurement*

*Electrostatic Discharge Association*
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*Rome, NY 13440*

ESD ASSOCIATION®

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# *ESD Association Standard Test Method for the Protection of Electrostatic Discharge Susceptible Items -*

## *Two-Point Resistance Measurement*

Approved September 19, 2004
ESD Association

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**FOREWORD**

This standard test method has been developed to establish a test method for measuring resistance where the concentric ring electrodes of ESD Standard Test Method 11.11 cannot be used. This method measures the resistance between two points on a material's surface without consideration of the material's means of achieving conductivity. Constant voltage instrumentation was used to collect the data used to validate this standard test method. Other instrumentation using an open circuit rated voltage supply is represented in this document as guidance.

Beneficial comments (recommendations, additions, deletions) and pertinent data, which may be of use in improving future versions of this document, should be addressed to: ESD Association
7900 Turin Road, Bldg. 3, Rome, NY 13440.

This Standard Test Method document was processed and approved for submittal to the ESD Association Standards Committee by the Packaging Subcommittee 11.0. At the time this Standard Test Method was approved; the subcommittee had the following members:

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| Stephen Koehn | Michael J. Manders<br>Air Force Research Laboratory |

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**ESD Association Standard Test Method for Two-Point Resistance Measurements.**

## 1.0 PURPOSE & SCOPE

### 1.1 Purpose

This standard test method provides a test method to measure the resistance between two points on an item's surface.

### 1.2 Scope

This standard test method is intended for measuring the resistance of items in the range of $10^4 \geq R < 10^{12}$ ohms.

## 2.0 REFERENCES

ANSI/ESD STM11.11 Surface Resistance Measurement of Static Dissipative Planar Materials.

EOS/ESD Advisory 1.0 Glossary of Terms.

ASTM D257-78 (re-approved 1983), Standard Test Method for D-C Resistance or Conductance of Insulating Materials

ASTM D2240 Standard Test Method for Rubber Property—Durometer Hardness[1]

## 3.0 DEFINITIONS

Terms used in this document are in accordance with the definitions found in ESD ADV1.0 *Glossary of Terms*.

## 4.0 GENERAL DISCUSSION

This method is recommended for testing items with irregularly shaped surfaces. Conventional concentric ring and parallel bar electrode configurations are used for testing planar items only. However, most packaging items are not planar. Examples include shipping tubes, trays, tote boxes and carrier tapes. This probe employs springs to apply consistent contact pressure between the electrode and the item. Force created by springs is subject to variance from wear, contamination and manufacturing tolerance. This variance is acceptable for this application. Elastomeric electrodes compensate for uneven item surfaces. These features yield consistent results between laboratories and test operators.

[1] ASTM 100 Barr Harbor Drive, West Conshohocken, PA 19428

## 5.0 EQUIPMENT

### 5.1 Probe

Refer to Figure 1 and Table 1.

This 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 ounces) ±10% at a travel of 0.00432 m (0.170 inches). The pin tips are machined to accept friction fitted 0.00318 m (0.125 inch) diameter electrically conductive rubber electrodes. The rubber has a Shore-A (IRHD) durometer hardness of 50-70 (ASTM Method D2240). The electrodes are 0.00318 m (0.125 inches) long. Electrode volume resistivity is <500 ohm-cm.

### 5.2 Sample Support Surface

An insulative surface when used for specimen support shall have a resistance of greater than $1.0 \times 10^{13}$ ohms when measured in accordance with ASTM D-257.

### 5.3 Resistance Measurement Apparatus

The measurement apparatus, called the meter, whether it is a single meter or a collection of instruments, have capabilities as follows:

a) **Meter for Laboratory Evaluations**
The meter shall have an output voltage of 100 volts (±5%) while under load for measurements of $1.0 \times 10^6$ ohms and above, and 10 volts (±5%) while under load for measurements less than $1.0 \times 10^6$ ohms. The meter must be capable of making measurements from $1.0 \times 10^3$ ohms (±10% accuracy) to $1.0 \times 10^{13}$ ohms (±10% accuracy).

® Teflon is a registered brand of DuPont

**b) Meter for Acceptance Testing**
The Laboratory evaluation meter may be used for acceptance testing or the following may be used. The meter shall have an open circuit voltage of 100 volts (±10%) for measurements of $1.0x10^6$ ohms and above, and 10 volts (±10%) for measurements less than $1.0x10^6$ ohms. The meter must be capable of making measurements from $1.0x10^3$ ohms (±20% accuracy) to $1.0x10^{13}$ ohms (±20% accuracy).

In case of disagreement, the meter used for Laboratory Evaluations will be used to resolve any disputes.

**c) Meter for Compliance Verification (Periodic Testing)**
A meter meeting the requirements of Laboratory Evaluations or Acceptance Testing may be used. The Compliance Verification meter must be capable of making measurements one order of magnitude above and below the intended measurement range. The output voltage of Compliance Verification meters may vary from laboratory evaluation or acceptance testing meters, and may be rated under load or open circuit. These meters must be correlated to the Acceptance Testing meter or the Laboratory Evaluation meter.

In case of disagreement, the meter used for Acceptance Testing meter or Laboratory Evaluations will be used to resolve any disputes.

NOTE: A constant voltage meter as noted above was used to collect all data used to validate this standard test method. Data was not collected to validate this equipment configuration.

### 5.4 Test Leads
Test leads appropriate for the meter are required. A shielded lead from the probe body to the instrument will greatly reduce electrical interference. Measurements for the verification of this test method were made using a shielded lead. See Figure 2.

### 5.5 Verification Resistors
The Low Resistance Verification Fixture will consist of a $1.0X10^5$ ohm (±1%) resistor bonded to two metal contact plates. The plates must be of size and shape so that each probe electrode contacts only one plate, and so that the plates are not in contact with each other. The plates may be affixed to a material with the same properties as the Sample Support Surface. Figure 3 illustrates one possible configuration of a Resistance Verification Fixture.

The High Resistance Verification Fixture will consist of a $1.0x10^9$ ohm (±5%) resistor bonded to two metal contact plates. The plates must be of size and shape so that each probe electrode contacts only one plate, and so that the plates are not in contact with each other. The plates may be affixed to a material with the same properties as the Sample Support Surface. Figure 3 illustrates one possible configuration of a Resistance Verification Fixture.

The actual value of the resistors should be measured periodically. This measured value should be used to verify probe operation.

## 6.0 SAMPLE PREPARATION

Condition six specimens of the item to be tested in an environment with a relative humidity of 12% ±3% and temperature of $23^o \pm 3^oC$ ($72 \pm 5^o$ F). Preconditioning of the samples shall be a period of at least 48 hours. All testing will be conducted in the preconditioned environment.

## 7.0 VERIFICATION PROCEDURE

Correct probe operation shall be verified by measuring known resistance values.

a) Connect the probe to the meter as shown in Figure 2.

b) Place the probe electrodes onto the Low Resistance Verification Fixture as shown in Figure 3.

c) Compress the spring-loaded pins downward approximately half of the length of travel (Figure 4).

d) Apply 10 volts for 15 seconds and observe the resistance.
e) Record the resistance value. The value should be within 10% of the actual resistor value.

f) Repeat the procedure using the High Resistance Verification Fixture at 100 volts.

## 8.0 TEST PROCEDURE

a) Connect the probe to meter as shown in Figure 2.

b) Place the specimen on the Sample Support Surface.

c) Compress the spring-loaded pins downward approximately half of the length of travel (Figure 4).

d) Apply 10 volts for 15 seconds and observe the resistance. If the resistance reading is less than $1.0x10^6$ ohms, record the resistance value and proceed to section “f”. If the resistance is greater than or equal to $1.0x10^6$ ohms, proceed to section “e”.

e) If the observed resistance in section “d” is greater than or equal to $1.0x10^6$ ohms, change the voltage to 100 volts and repeat the measurement. Record the resistance value.

f) Repeat the test for each remaining specimen.

## 9.0 TEST RESULTS

Report the actual humidity, temperature, and conditioning time, test voltage and resistance for each specimen.

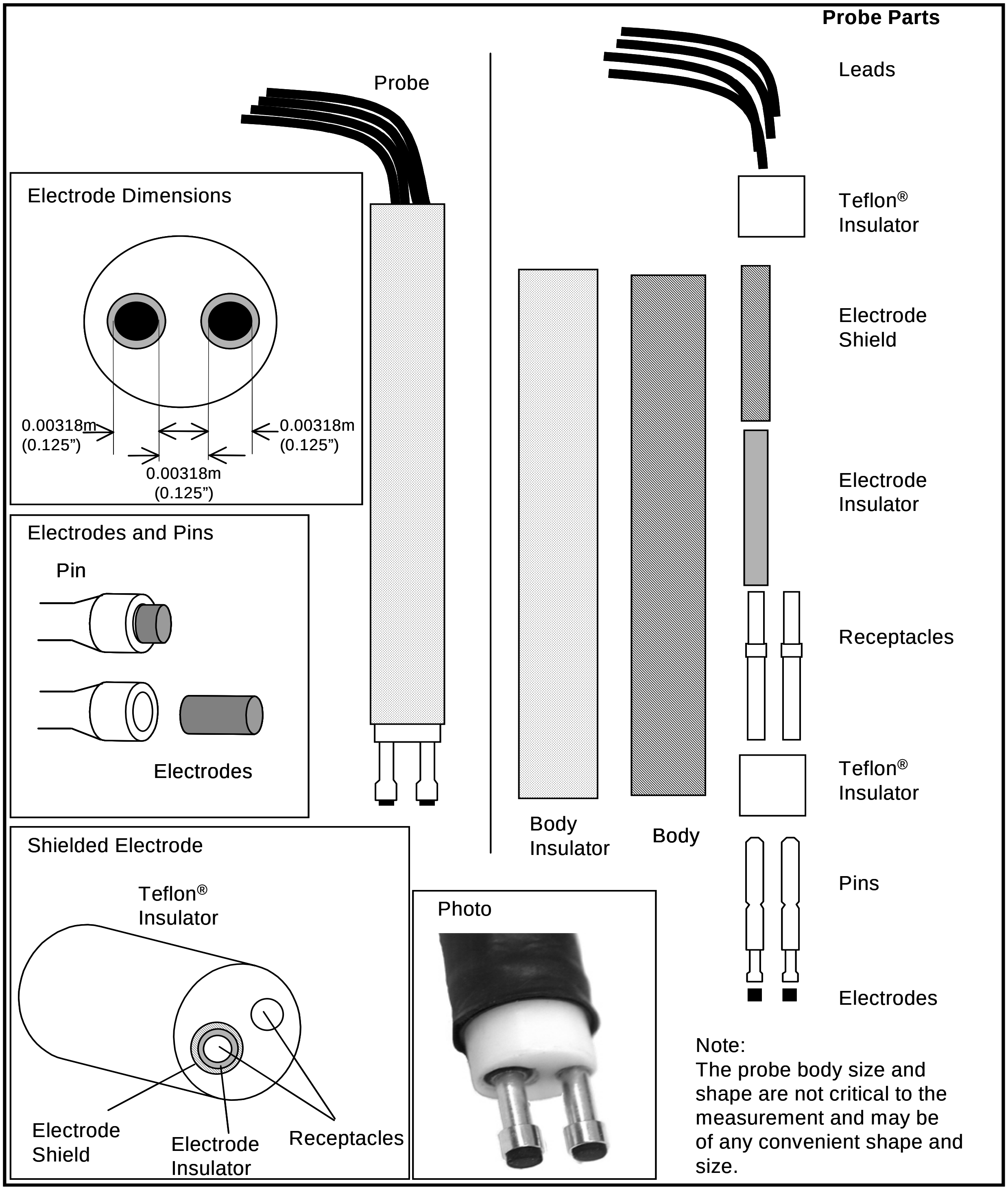


*Figure 1: Two Point Probe Configuration (see Table 1 for key components list)*

***Table 1: Material for Two-Point Probe***

Note: This is not intended to be a complete materials list for probe construction, but does provide key elements that enable performance replication. Refer to Figure 1 for part placement. Part manufacturers and numbers information are for reference. Equivalent parts may be used.

| | | |
|---|---|---|
| Teflon® Insulators | Approx. 0.0254m (1.0in) by 0.0127m (0.5in) diameter. | |
| Electrode Shield | Metal tubing approx.<br>0.0318m (1.25in) by 0.00475m (0.187in) diameter. | |
| Electrode Insulator | Heat shrinkable Teflon® or other insulator | |
| Receptacles | Receptacle – with solder cup | Interconnect Devices Inc. R-5-SC |
| Pins | Spring Pins 0.465kg (16.4oz) at 0.00432m (0.170in) travel. Tip machined to accept electrode | Interconnect Devices Inc. S-5-F-16.4-G |
| Electrodes | 0.00318m (0.125in) by 0.00318m (0.125in) diameter conductive material with a Shore A (IRHD) durometer hardness between 50 and 70. Volume resistivity to be <500 ohm-cm. | Vanguard Products, VC-7815 |

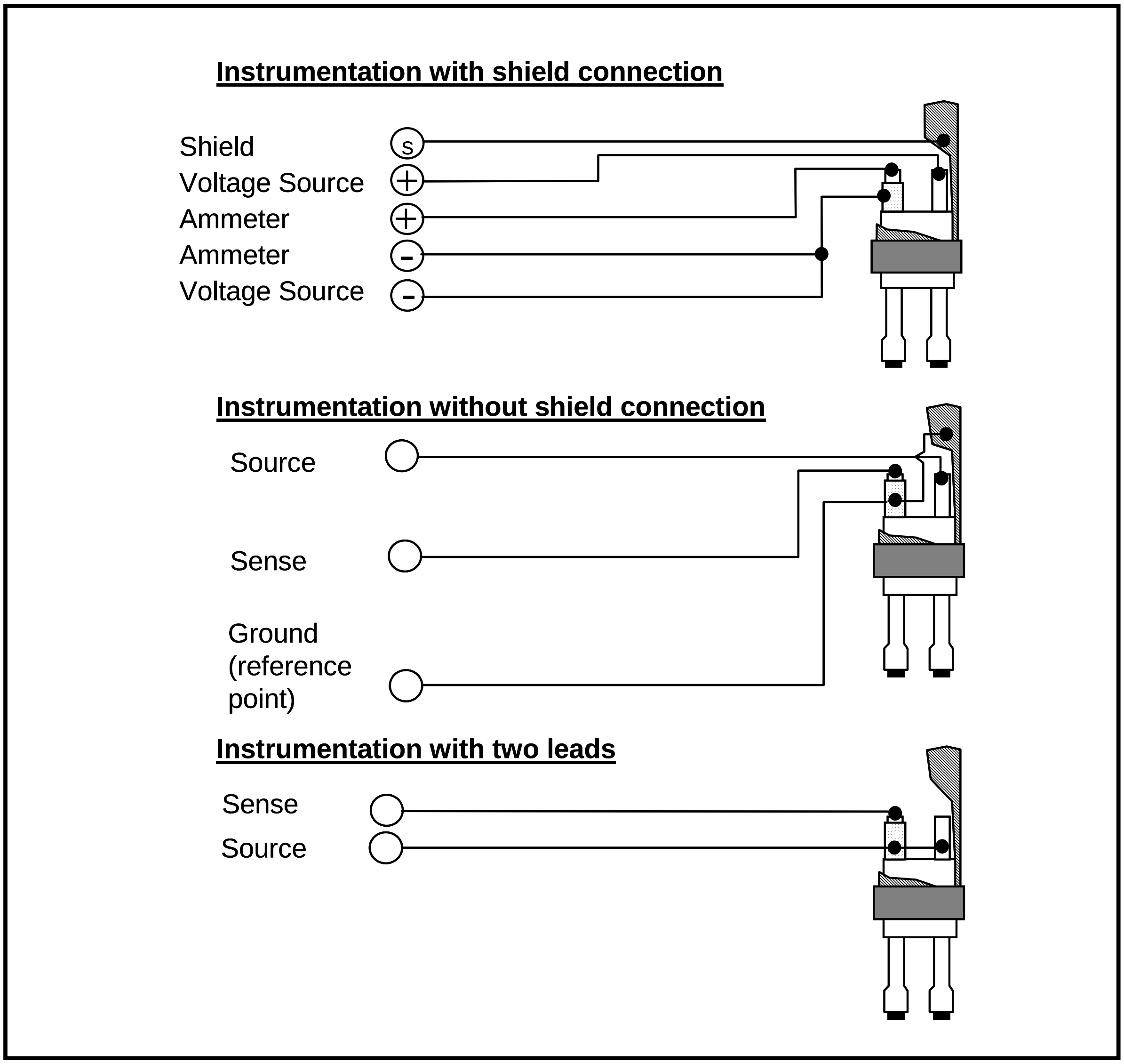


*Figure 2: Probe to Instrumentation Connection*

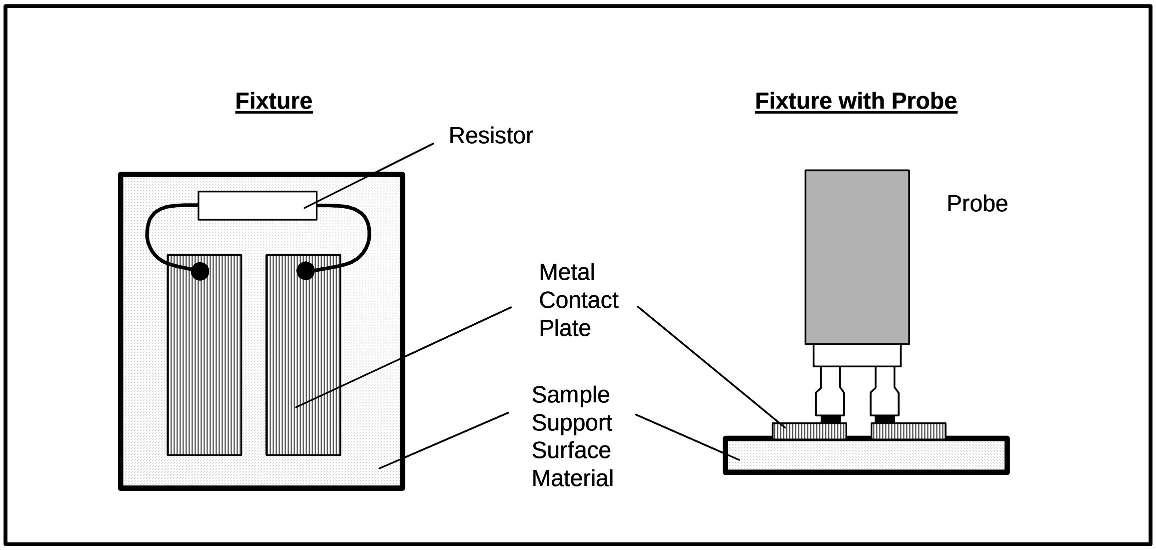


*Figure 3: Resistance Verification Fixture*

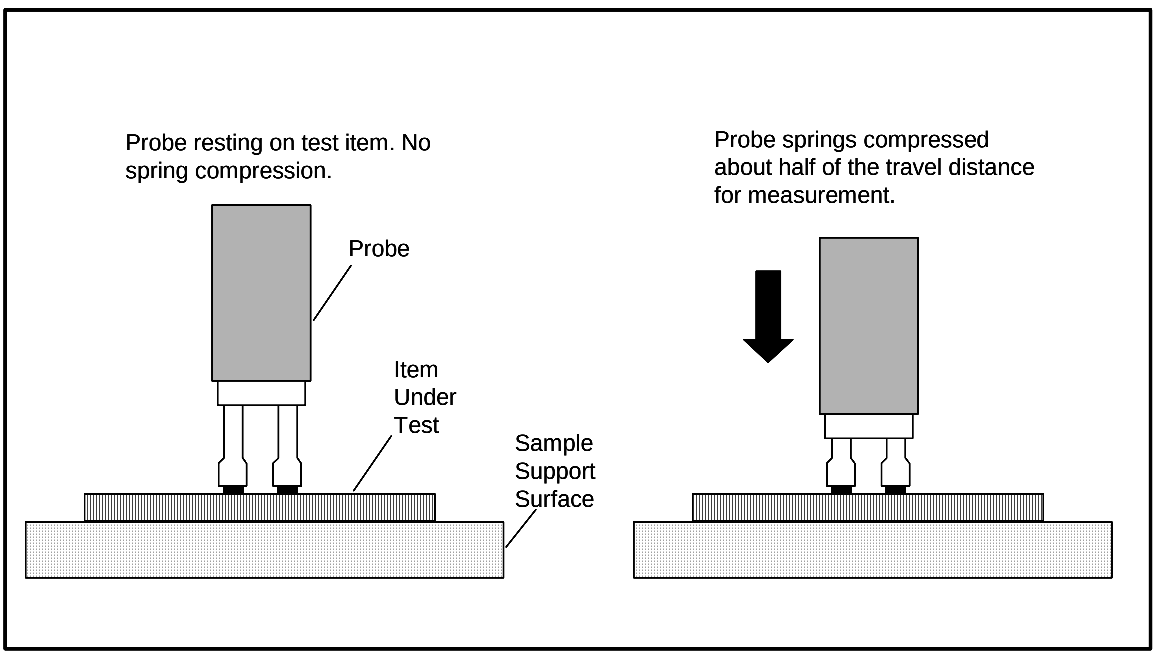


*Figure 4: Spring Compression for Measurement*

## APPENDIX A

## TEST METHOD NOTES

A1. A change in the size of the specimen can affect the measurements.

A2. Resistance measurements can be affected by the size and spacing between electrodes. The 0.00318 m (0.125 inch) diameter and 0.00318 m (0.125 inch) spacing of the electrodes was selected to test a wide range of packaging types and sizes.

A3. Resistance measurements of a particular sample material may vary due to:

- Variations in sample surface composition or thickness.
- Compression of the sample by the force of the electrodes.
- Variations of the resistance in the electrode material.
- Change in material properties due to the measurement current.
- Cleanliness of electrodes or sample.

A4. Testing of various electrode materials indicates that the use of harder rubber materials than specified creates greater variation in readings.