Designation: F1896 – 16

Test Method for Determining the Electrical Resistivity of a Printed Conductive Material[1]

This standard is issued under the fixed designation F1896; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the electrical resistivity of a conductive material as used in the manufacture of a membrane switch.

1.2 This test method is not suitable for measuring force sensitive conductive materials.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Terminology

2.1 *Definitions:*

2.1.1 *membrane switch*—a momentary switching device in which at least one contact is on, or made of, a flexible substrate.

2.1.2 *circuit/test pattern resistance*—electrical resistance as measured between two terminations of a circuit trace.

2.1.3 *square*—A geometric unit of a printed conductive circuit trace/pattern obtained by dividing the length (*L*) of the printed conductive circuit trace/pattern by its width (*W*).

2.1.4 *resistivity*—ohms per square per mil of a conductive material.

3. Significance and Use

3.1 Resistivity is useful to suppliers and manufacturers as follows:

3.1.1 when designing membrane switch interface circuitry,

3.1.2 when selecting the appropriate conductive material,

3.1.3 for conductive material quality verification, and

3.1.4 for conductive material cure optimization and quality control.

4. Interferences

4.1 The accuracy of the resistivity determination will be improved as the number of squares of the resistance test strip is increased. The accuracy of the resistivity determination will be improved as the width (*W*) of the circuitry test pattern is increased. Some conductive materials' resistivity are sensitive to temperature.

5. Apparatus

5.1 *Resistance Measuring Device,* (that is, ohm meter) equipped with test leads and probes. The device should be capable of measuring resistances up to 100 MΩ with an accuracy of greater than 1.5 % of full scale reading. Test probes should have tips that are 25 to 250 % of the width (*W*) of the printed conductor test pattern. If your device is not equipped with a feature that allows the resistance of the leads to be negated then measure the lead resistance and subtract that from the resistance measurements.

5.2 *Test Surface,* to be flat, smooth, unyielding and larger than circuit under test.

5.3 *Thickness Measuring Device,* capable of measuring to the nearest 0.00005 in. (1.25 µm).

5.4 *Dimensional Measuring Device,* capable of measuring to the nearest 0.001 in. (25 µm).

6. Procedure

6.1 *Pre-Test Setup:*

6.1.1 Secure circuit (that is, printed and cured conductive material) on the test surface.

6.1.2 Measure the geometry of the test pattern as follows:

6.1.2.1 Measure the length (*L*) of the printed test pattern. (*L*) is the length of the conductive path between test probes.

NOTE 1—It is possible that (*L*) is smaller than (*W*).

6.1.2.2 Measure the width (W) of the printed test pattern.

6.1.2.3 Divide the length (L) by the width (W) to calculate the number of squares of the printed test pattern.

NOTE 2—Measuring the length (L) and width (W) of the actual printed

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pattern checks the accuracy of the actual number of squares printed versus the artwork.

6.2 *In-Process Test:*

6.2.1 Using the resistance measuring device (that is, ohm meter), measure the resistance of the printed test pattern. Place probes at ends of measured length of the test pattern as shown in Fig. 1.

NOTE 3—Reminder to zero out test probe leads.

6.2.2 Record resistance in ohms.

6.2.3 Using the thickness measuring device, measure the thickness (*t*) of the printed test pattern in mils, measure in a minimum of three locations across the test pattern.

6.2.4 Record average thickness (*t*) in mils (1 mil = 25 µm).

6.3 *Calculations:*

6.3.1 Determine the number of squares of the printed test pattern by dividing the length (*L*) by the width (*W*). Record the number of squares.

6.3.2 Determine the ohms per square by dividing the measured resistance (in ohms) by the number of squares. Record the ohms per square.

6.3.3 Determine the resistivity (ohms per square per mil) of the conductive material by multiplying the ohms per square by the measured thickness (*t*) in mils. Record the resistivity of the conductive material (ohms per square per mil).

6.3.4 *Examples:*

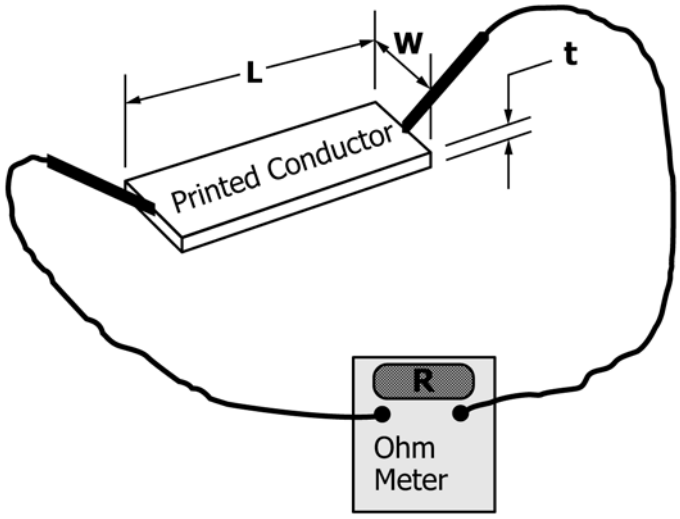

FIG. 1 Resistance Measurement Test Set-Up

6.3.4.1 Example No. 1 is as follows:

Resistance Measurement: 3.0 Ω
Thickness (*t*) Measurement: 0.50 mils (12.5 µm)
Number of Squares: 100 squares

Ohms per square = 3.0 Ω/100 squares
Ohms per square = 0.03 Ω per square

Resistivity (ohms per square per mil) = 0.03 Ω per square × 0.50 mils
Resistivity (ohms per square per mil) = 0.015

6.3.4.2 Example No. 2 is as follows:

Resistance Measurement: 3.0 Ω
Thickness (t) Measurement: 12.5 µm
Number of Squares: 100 squares

Ohms per square = 3.0 Ω/100 squares
Ohms per square = 0.03 Ω per square

Resistivity (ohms per square per inch) = 0.03 Ω per square × 0.0005 in.

Resistivity (ohms per square per inch) = 0.000015
Resistivity (ohms per square per mil) = 0.000015 × 1000 mils per inch
Resistivity (ohms per square per mil) = 0.015

7. Report

7.1 Report the following information:

7.1.1 Temperature,

7.1.2 Humidity,

7.1.3 Resistance (ohms),

7.1.4 Number of squares,

7.1.5 Thickness (*t*) of the test pattern,

7.1.6 Resistivity (ohms per square per mil),

7.1.7 Part number or description, or both, of the test pattern/switch,

7.1.8 Identify termination points, and

7.1.9 Date of test.

8. Precision and Bias

8.1 *Precision*—It is not possible to specify the precision of the procedure in Test Method F1896 for measuring the resistivity because inter-laboratory studies have proven inconclusive due to insufficient participating laboratories with the appropriate equipment.

8.2 *Bias*—No information can be presented on the bias of the procedure in Test Method F1896 for measuring resistivity because no standard sample is available for this industry.

9. Keywords

9.1 conductive material; membrane switch; resistivity

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