IPC-TM-650
TEST METHODS MANUAL

Number 2.5.3.7	
Subject Electrical Resistance and Sheet Resistance of E-Textiles – Instrumental Assessment of Conductive Threads and Tracks	
Date 02/2025	Revision
Gage R&R: ☐ Complete ☑ In Progress ☐ Available ☐ NO	
Originating Task Group: D-74b E-Textiles Exposure and Durability Test Methods Task Group	

1 SCOPE

This test method is used to measure the electrical resistance and sheet resistance of e-textiles.

2 APPLICABLE DOCUMENTS

2.1 Deutsches Institut für Normung (DIN)[1]

EN 16812 Textiles and textile products - Electrically conductive textiles - Determination of the linear electrical resistance of conductive tracks

2.2 International Organization for Standardization (ISO)[2]

ISO 139 Textiles Standard atmospheres for conditioning and testing

3 TEST SPECIMENS

3.1 Specimen Preconditioning All test specimens **shall** be conditioned for ≥ 24 hours according to ISO 139. If other conditions are specified, they should be reported with the test results.

3.2 Specimen Description Specimen **shall** be prepared according to EN 16812, with the following additions:

Exclusively conductive or electrically functional parts of the e-textile (textile motherboard, textile area sensors, textile antenna, textile electrodes, etc.) **shall** be tested. If an e-textile has multiple types conductive structures and networks (nets), each type of conductive structures **shall** be tested. Tested structures **shall** have a length of at least 100 mm.

If the e-textile to be tested is loose fiber, comb and compress enough of it to form a sheet measuring at least 40 mm x 100 mm.

If applicable, remove insulation from conductive structures at measuring points for data recorder attachment.

3.3 Number of Specimens The number of test specimens **shall** be defined to respect the statistical treatment (at least five per type of conductive structure).

4 APPARATUS AND MATERIAL

4.1 Resistance meter for assessing linear electrical resistance for linear conductive structures, (complying with EN 16812).

4.2 Four-probe inductive measurement for assessing sheet resistance

5 PROCEDURE

5.1 Calibrate the electrical resistance meter and the four-probe device according to the manufacturer's recommendations or industry standards.

1 www.din.de
2 www.iso.org

5.2 Measure initial resistance R0 of each sample after conditioning, either according to line resistance standard for linear conductive structures integrated into the textile substrate or sheet-resistance standard for conductive areas using the four-probe measurement. If multiple linear conductive structures are present in one sample, R0 needs to be measured separately for each line. Remove insulating materials if necessary to allow for resistance measurement.

5.3 Condition the test specimens in a suitable testing chamber or conditioning room at a predetermined relative humidity (RH) that will reflect the conditions at which information on the electrical resistivity of the fabric is needed.

Note: For most fabrics that require antistatic treatments or whose static propensity is critical, measurements at 20% RH will be most meaningful. In less critical situations 40% RH may be employed.

For special requirements, other RH values may be used. For example, preconditioning at 50% RH ± 2% RH at 21 °C ± 2 °C [70 °F ± 4 °F] may be needed for antistatic sheeting, film and textiles for use in hospital operating rooms. Measurements may be made under other conditions or ranges of conditions that apply to the end-use (such as 65% RH and 24 °C). It is preferable to keep the temperature or humidity consistent for all measurements.

If it is necessary to measure resistance and electrical sheet resistance under a broad range of conditions, additional tests may be run at 65% RH and 24 °C [75.2 °F] or other settings applicable to the end-use. It is preferable to keep the temperature or humidity consistent for all measurements.

5.4 Place a test specimen in firm contact with the electrodes such that the test results are not affected.

In the case of equipment using parallel plate electrodes, place the test specimen in contact with the electrodes with the direction of the test perpendicular to the adjacent edges of the electrode. Measure the electrical resistance of the fabric in both the length and width directions. Since the charge will follow the path of least resistance, record only the lower reading by direction.

5.5 Measure the electrical resistance of the test specimen according to the operating instruction and procedures for the resistance meter being used. Allow the current to pass through the test specimen for 60 seconds or until a constant reading is obtained. The criterion for constant electrical resistance is a change in the value of Log R of less than 0.1 units per minute. The time to reach a constant reading may vary with the applied voltage and with the resistance of the test sample. High voltages for prolonged periods may damage the fabric.

Avoid the use of any electrically conductive liquids on either the fabric test specimens or the apparatus.

6 TEST REPORT

The report **shall** contain the following information:

- Date and time of test
- Testing location and name of tester
- Environmental test conditions (if differing from ISO 139)
- Number of test specimens
- Description of test specimens (size, cutting direction (warp/weft (wovens), course/wale (knits)), type of critical area, location of critical area within specimen, etc.)
- Description/Specifications of testing equipment
- Testing parameters/specifications (climate conditions, other info)
- Test results (resistance values)
- Any deviations from the presented methods
- Comments

7 NOTES

7.1 Safety Precautions These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all-inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this Test Method. Manufacturers need to be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules should also be consulted and followed. Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

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