Standard Test Method for Volume Resistivity for Extruded Crosslinked and Thermoplastic Semiconducting Conductor and Insulation Shielding Materials[1]

This standard is issued under the fixed designation D 6095; 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 procedure for determining the volume resistivity of extruded crosslinked and thermoplastic semiconducting, conductor and insulation shields for wire and cable.

1.2 Whenever two sets of values are presented, in different units, the values in the first set are the standard, while those in parentheses are for information only.

1.3 *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.* For a specific hazard statement, see 7.1.

1.4 In common practice the conductor shield is often referred to as the strand shield.

1.5 While technically the volume resistivity in this test method is a longitudinal volume resistivity, in the wire and cable industry the word longitudinal is not used.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1711 Terminology Relating to Electrical Insulation[2]

D 4496 Test Method of DC-Resistance or Conductance of Moderately Conductive Materials[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *semiconducting,, adj*—moderately conductive, see Terminology D 1711 and Test Method D 4496.

3.1.2 *longitudinal volume resistivity,, n*— the measurement of a resistance between two electrodes attached to one and only one surface of the specimen resulting in a current path parallel to the axis of the cable and perpendicular to the plane of the electrodes.

3.1.2.1 *Discussion*—In normal wire and cable usage, the word longitudinal is not used.

4. Significance and Use

4.1 The electrical behavior of semiconducting extruded shielding materials is important for a variety of reasons, such as safety, static charges, and current transmission. This test method is useful in predicting the behavior of such semiconducting compounds. Also see Test Method D 4496.

5. Apparatus

5.1 See Test Method D 4496 for a description of the apparatus, except the electrode system which is described in 7.2.

6. Sampling and Test Specimens

6.1 Take one 2-ft (600-mm) sample from each lot, or from each 25000 ft (7600 m) of completed cable, whichever is less.

6.2 The specimen consists of a 10 in. (250 mm) length of cable core with all layers external to the semi-conducting insulation shield removed. Use this specimen to test the insulation shield. To test the conductor shield, bisect the sample longitudinally and remove the conductor. Use only one piece of the conductor shield as the test specimen.

6.3 Condition the specimens in accordance with Test Method D 4496.

6.3.1 If the shielding materials are crosslinked, condition the cable core (jacket removed) overnight at 50°C to eliminate any acetophenone that may be present. Then proceed with the conditioning in accordance with Test Method D 4496.

7. Procedure

7.1 **Warning**—Insert the latest version of high-voltage caveat here.

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[1] This test method is under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.18 on Solid Insulations, Nonmetallic Shieldings and Coverings for Electrical and Telecommunication Wires and Cables.

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 10.02.

7.2 Apply an electrode system consisting of four annular bands of silver paint approximately 0.25 in. (6.5 mm) wide to the insulation shield. There must be a distance of at least 2 in. (50 mm) of shield between the potential electrodes (the two inner bands) and a distance of 1 in. of shield between the current electrodes (the outer bands) and the potential electrodes. See Annex A1 of Test Method D 4496.

7.3 For measurement of the conductor shield, bisect the sample longitudinally and remove the conductor. Then, using only one piece of the bisected shield, apply the silver paint electrode system as described in 7.2 only to the conductor shield.

7.4 Condition the specimen for 1 h at the rated operating temperature of the cable to ensure thermal equilibrium of the specimen.

7.5 Determine the resistance between the potential electrodes of the test specimen using a direct test voltage and a measuring system meeting the requirements of Test Method D 4496. Make two measurements, one at 23 ± 2°C (73 ± 4°F) and one at the rated operating temperature of the insulation material. See the procedure and Appendix X1 of Test Method D 4496 concerning the prevention of specimen self-heating. Limiting the power to 100 mW and the test time to 1 min is recommended.

7.6 When a high degree of accuracy is not required, use a two-electrode method employing any technique that permits the resistance to be measured with an accuracy of ±5 %. Space the electrodes at least 2 in. (50 mm) apart. Make two tests, one at 23 ± 2°C (73± 4°F) and one at the rated operating temperature of the insulation material.

8. Calculation

8.1 For each shielding material and each temperature, calculate the volume resistivity by using the following equations:

Insulation Shielding:

$$\rho = [2R(D_b^{\,2} - d_b^{\,2})]/L \quad (1)$$

Conductor Shielding:

$$\rho = [R(D_a^{\,2} - d_a^{\,2})]/L \quad (2)$$

where:

ρ = volume resistivity, Ω-cm,
R = measured resistance, Ω,
L = distance between potential electrodes, in.,
D_a = diameter over conductor shielding, in.,
d_a = diameter over conductor, in.,
D_b = diameter over insulation shielding, in., and
d_b = diameter over insulation, in.

NOTE 1—Even though the dimensions are measured in inches, the value of the volume resistivity is reported in Ω-cm. This is because not all constants and conversion factors are shown in Eq 1 and Eq 2. See Appendix X1 for a discussion on the derivation of the formulas.

9. Report

9.1 Report the following information:

9.1.1 Sample conditioning time and temperature,

9.1.2 The volume resistivity, Ω-cm, of the conductor shielding material at 23 ± 2°C,

9.1.3 The volume resistivity, Ω-cm, of the conductor shielding material at the temperature rating of the insulation,

9.1.4 The volume resistivity, Ω-cm, of the insulation shielding material at 23 ± 2°C,

9.1.5 The volume resistivity, Ω-cm, of the insulation shielding material at the temperature rating of the insulation, and

9.1.6 The electrode system used.

10. Precision and Bias

10.1 *Precision*—This test method has been in use for many years, but no statement for precision has been made and no activity is planned to develop such a statement.

10.2 *Bias*—A statement of bias is not possible due to a lack of a standard reference material.

11. Keywords

11.1 conductor shield; conductor shielding material; insulation shield; insulation shielding material; moderately conductive; semiconducting shielding materials; semiconducting shields; volume resistivity of shielding materials

APPENDIX

(Nonmandatory Information)

X1. DERIVATION OF FORMULAS FOR VOLUME RESISTIVITY

X1.1 Insulation Shielding Material Fig. X1.1

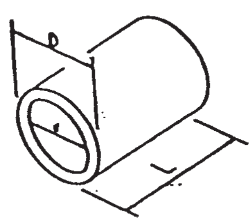

FIG. X1.1 Insulation Shield

$$\rho = R\,(A/L) \quad (X1.1)$$

$$A = [(\pi D^2)/4] - [(\pi d^2)/4] = [\pi(D^2 - d^2)]/4 \quad (X1.2)$$

$$\rho = [R\pi(D^2 - d^2)]/4L \quad (X1.3)$$

where:

ρ = volume resistivity, Ω-cm,
R = measured resistance, Ω,
D = diameter over insulation shielding, in.,
d = diameter over insulation, in., and

L = distance between potential electrodes, in.

X1.1.1 In Eq X1.3, substituting the numerical value for π and converting the values in inches to centimetres results in Eq X1.4 which is the same as Eq 1 in 8.1 which gives the volume resistivity in the customary units of Ω-cm.

$$\rho = [2R\,(D^2 - d^2)\,]/L \qquad \text{(X1.4)}$$

X1.2 Conductor Shielding Material Fig. X1.2

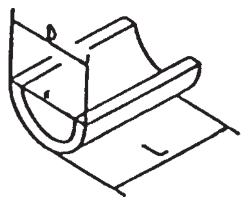

FIG. X1.2 Conductor Shield

$$\rho = R(A/L) \qquad \text{(X1.5)}$$

$$A = \{[\,(\pi D^2)/4] - [\,(\pi d^2)/4]\}/2 = \{[\pi D^2 - d^2)\,]\}/8 \qquad \text{(X1.6)}$$

$$\rho = [R\pi\,(D^2 - d^2)\,]/8L \qquad \text{(X1.7)}$$

where:

ρ = volume resistivity, Ω-cm,
R = measured resistance, Ω,
D = diameter over conductor shielding, in.,
d = diameter over conductor, in., and
L = distance between potential electrodes, in.

X1.2.1 In Eq X1.7, substituting the numerical value for π and converting the values in inches to centimetres results in Eq X1.8 which is the same as Eq 2 in 8.1 which gives the volume resistivity in the customary units of Ω-cm.

$$\rho = [R\,(D^2 - d^2)\,]/L \qquad \text{(X1.8)}$$

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