Designation: D4566 – 14

Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable[1]

This standard is issued under the fixed designation D4566; 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 These test methods cover procedures for electrical testing of thermoplastic insulations and jackets used on telecommunications wire and cable and for the testing of electrical characteristics of completed products. To determine the procedure to be used on the particular insulation or jacket compound, or on the end product, reference should be made to the specification for the product.

1.2 The test methods appear in the following sections of this standard:

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.* Specific hazard statements are given in Sections 6 and 37.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B193 Test Method for Resistivity of Electrical Conductor Materials

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D1711 Terminology Relating to Electrical Insulation

D2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable

D3426 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials

[1] These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.18 on Solid Insulations, Non-Metallic Shieldings and Coverings for Electrical and Telecommunication Wires and Cables.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

Using Impulse Waves
D5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *ANSI Standard:*
ANSI/IEEE Standard 100 IEEE Standard Dictionary of Electrical and Electronics Terms[3]

2.3 *IEC Standard:*
IEC 61156-1 Multicore and Symmetrical Pair/Quad Cables for Digital Communications—Part 1: Generic Specification[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this standard, refer to Terminology D1711.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air core, n*—refers to products in which the air spaces between cable core components (pairs, etc.) remain in their unfilled or natural state.

3.2.2 *armored wire or cable, n*—wire or cable in which the shielded or jacketed or shielded and jacketed wire or cable is completely enclosed by a metallic covering designed to protect the underlying telecommunications elements from mechanical damage.

3.2.3 *cable, telecommunications, n*—products of six or more pairs.

3.2.4 *filled core, n*—those products in which air spaces are filled with some materials intended to exclude air or moisture, or both.

3.2.5 *low frequency cable, n*—cable used for transmitting signals at a frequency of 2 MHz or less.

3.2.6 *pair, n*—two insulated conductors combined with a twist.

3.2.7 *sheath, n*—the jacket and any underlying layers of shield, armor, or other intermediate material down to but not including the core wrap.

3.2.8 *shielded wire or cable, n*—wire or cable in which the core (or inner jacket) is completely enclosed by a metallic covering designed to shield the core from electrostatic or electromagnetic interference, or both.

3.2.9 *wire, telecommunications, n*—products containing less than six pairs.

ELECTRICAL TESTS OF INSULATION—IN-PROCESS

4. Scope

4.1 In-process electrical tests are used primarily as process control tools in an attempt to minimize the number and magnitude of problems detected at final test of completed cable.

[3] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, http://www.global.ihs.com.

5. Significance and Use

5.1 Electrical tests, properly interpreted, provide information with regard to the electrical properties of the insulation. The electrical test values give an indication as to how the insulation will perform under conditions similar to those observed in the tests. Electrical tests provide data for research and development, engineering design, quality control, and acceptance or rejection under specifications.

6. Spark Test

6.1 The spark test is intended to detect defects in the insulation of insulated wire conductors. Spark testers are commonly used to detect insulation defects (faults) at conductor insulating operations, at pair twisting operations, and (occasionally) at operations for assembly or subassembly of conductors. In selected instances, spark tests are used to detect defects in the jackets of shielded wire and cable, and in such cases, spark testers appear on cable jacketing lines. The basic method calls for a voltage to be applied between a grounded conductor and an electrode that is in mechanical contact with the surface of the material being tested. The wire or cable under test usually moves continuously against the electrode. When the dielectric medium is faulty (for example, excessively thin or missing, as in a pin-hole or when mechanically damaged), the impressed voltage will produce an arc to the grounded conductor. This arcing or sparking will usually activate one or more indicators (such as, warning buzzers or lights, counters, etc.) and, when appropriately interlocked, are sometimes used to halt the production or movement of the item through the spark tester electrode. For telecommunications products, the number of faults is usually only counted while production continues. Jacket defects are sometimes flagged when detected. Jacket defects and units of insulated wire containing an excessive number of faults are either repaired or disposed of.

6.2 **Warning—**Lethal voltages Lethal voltages are a potential hazard during the performance of this test. It is essential that the test apparatus, and all associated equipment electrically connected to it, be properly designed and installed for safe operation.

6.2.1 Solidly ground all electrically conductive parts which it is possible for a person to contact during the test.

6.2.2 Provide means for use at the completion of any test to ground any parts which were at high voltage during the test or have the potential for acquiring an induced charge during the test or retaining a charge even after disconnection of the voltage source.

6.2.3 Thoroughly instruct all operators as to the correct procedures for performing tests safely.

6.2.4 When making high voltage tests, particularly in compressed gas or in oil, it is possible for the energy released at breakdown to be sufficient to result in fire, explosion, or rupture of the test chamber. Design test equipment, test chambers, and test specimens so as to minimize the possibility of such occurrences and to eliminate the possibility of personal injury. If the potential for fire exists, have fire suppression equipment available.

6.3 Unless otherwise limited by detailed specification requirements, spark testers used generate either an ac or dc test

voltage; if ac, one or more of various frequencies are used. For safety to personnel, spark test equipment is usually current-limited to levels normally considered to be non-lethal. Unless otherwise specified, the test voltage level employed shall be at the discretion of the manufacturer.

6.4 Unless otherwise limited by detailed specification requirements, various types of electrodes such as bead chains, water, ionized air and spring rods are among electrode types that have been successfully employed at the discretion of the manufacturer. The length of the electrode is also variable; unless otherwise limited by detailed specification requirements, electrode size and length shall be such that the tester will operate successfully for any particular rate of travel of the product through the tester that is used. In spite of current limitations, electrodes are normally provided with grounded metallic screens or shields to guard against accidental personnel contact.

6.5 Both ends of the conductor of an insulated wire, or both ends of a metallic shield under a cable jacket are grounded, and then attached to the ground side of the tester. Attach the high voltage side of the tester to the sparker electrode. Set the test voltage at the level specified. Unless otherwise specified, energize the spark tester whenever the product to be tested is moving through the electrode. Take appropriate action (for example, flag defects, count defects, adjust the process, etc.) when and if defects are detected.

6.6 *Report:*

6.6.1 Report the following information recorded on suitable forms (that is, production reports):

6.6.1.1 Machine number and type (that is, extruder, twister, etc.),

6.6.1.2 Date of production test,

6.6.1.3 Insulation type (air core or filled core), conductor gage and footage,

6.6.1.4 Voltage level, and

6.6.1.5 Number of indicated faults.

6.7 *Precision and Bias*—The precision of this test has not been determined. No statement can be made about the bias of this spark test since the result merely states whether there is conformance to the criteria for success specified in the product specification.

7. Insulation Defect or Fault Rate—In-Process

7.1 For purposes of in-process quality control, it is desirable to monitor and record in-process faults at a particular operation (such as, extruders, twisters, etc.) and relate the number of defects found to the quantity of product produced.

7.2 When appropriate, and using records of the quantity of product produced versus the number of insulation defects counted, a fault rate such as the following ratio is used:

$$\text{Fault Rate} = \frac{N}{L} = \frac{1}{X} \quad (1)$$

where:

N = the number of faults detected,

L = the length of the product over which the faults are detected, and

X = the average length of the product per fault.

7.3 Fault rates are determined for any particular time frame as desired; however, minimum industry practice is to keep fault rate records covering periods approximating 1 month, with cumulative records kept for 6-month periods (for example, for the first 6 months of the year, the fault rate was 1/40 000 ft, meaning 1 fault/40 000 conductor ft).

7.4 *Report*—Report in accordance with 6.6.

7.5 *Precision and Bias*—The precision of this test has not been determined. No statement can be made about the bias of this test for insulation defect or fault rate since the result merely states whether there is conformance to the criteria for success specified in the product specification.

8. DC Proof Test—In-Process

8.1 For purposes of in-process quality control, it is desirable to dc proof test product at one or more stages of processing prior to the final test operation. Such testing is normally at the discretion of the manufacturer.

8.2 Conduct wire-to-wire dc proof tests in accordance with Section 37 at a suitable stage of production as designated by the factory management.

8.3 *Report*—Report in accordance with Section 52 except that 52.1.5 does not apply.

8.4 *Precision and Bias*—The precision of this test has not been determined. No statement can be made about the bias of this dc proof test since the result merely states whether there is conformance to the criteria for success specified in the product specification.

ELECTRICAL TESTS OF COMPLETED WIRE AND CABLE

9. Scope

9.1 Electrical tests of completed wire and cable include verification of some or all of the properties in accordance with Sections 11 through 51.

10. Significance and Use

10.1 Electrical tests, properly interpreted, provide information with regard to the electrical properties of the insulation or of the jacket, or both. The electrical test values give an indication as to how the wire or cable, or both, will perform under conditions similar to those observed in the tests. Electrical tests provide data for research and development, engineering design, quality control, and acceptance or rejection under specifications.

11. Conductor Continuity

11.1 Continuity of the conductors of a telecommunications wire and cable is a critical characteristic.

11.2 Unless otherwise specified or agreed upon, conductor continuity shall be verified using a dc potential of 100 V or less. Manual continuity checkers commonly take a form of a