

EIA RS-199-A

EIA STANDARD

*Solid and Semi-Solid
Dielectric Transmission Lines*

RS-199-A
(Revision of RS-199)



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Engineering Department
ELECTRONIC INDUSTRIES ASSOCIATION

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SOLID AND SEMI-SOLID DIELECTRIC TRANSMISSION LINES

(From RS-199 and Standards Proposal No. 1105, formulated under the cognizance of ANSI Subcommittee C83.3 on RF Cable.)

1. SCOPE

1.1 General

This standard refers to solid- and semi-solid-dielectric coaxial-cable transmission lines consisting of one or two inner conductors.

1.1.1 Coaxial Cables

Basically, a coaxial cable is constructed of a single inner conductor covered by a flexible low-loss r-f-dielectric core material, which is then surrounded by a braided outer conductor, with the whole covered by a protective covering. In some cases this is covered by an extra outer braided armor for use in extremely abusive applications. Each element of the construction is designed to contribute to the requirements of the finished product.

1.1.2 Two-Conductor Coaxial Cables

Individual dielectric cores of two-conductor coaxial cables shall meet the requirements of solid or semi-solid dielectric cores. One strand of one of the inner conductors shall be coded for identification and shall be visible without disturbing the stranding. That is, if all of the strands of the inner conductors are coated, then one strand shall be bare; or if all of the strands are bare, then one strand shall be coated.

1.1.2.1 Twin-Coaxial Cables

Twin-coaxial cables shall be constructed of individual inner conductors within individual dielectric cores, within a common outer-conductor braid. As an alternate construction, a twin-coaxial cable may be constructed of individual inner conductors within individual inner dielectric cores, within a common outer core that may be filled-to-round.

1.1.2.2 Dual-Coaxial Cables

Dual-coaxial cables shall be constructed of individual inner conductors within individual dielectric cores, within individual outer conductor inner braids, within a common outer conductor outer braid.

1.2 Application

Coaxial cables covered by this standard are primarily intended for use as transmission lines to conduct

energy in a simple power transfer, continuously or intermittently. In general, these coaxial cables are designed for low-loss stable operation from the relatively low radio frequencies thru the higher frequencies encountered in the microwave and radar regions of the frequency spectrum. Typical uses include runs of cable carrying critically exact signals between or within units of electronic, radio, television or other communication equipment. Coaxial cables may also be used as circuit elements, delay lines or impedance matching devices.

2. PURPOSE

The primary object of this standard is to insure the uniformity of similar-type coaxial cables obtained from different sources of supply. It is also intended that this standard shall serve as a guide in the manufacture and application of these cables.

In view of the extensive use of solid- and semi-solid-dielectric coaxial cables requiring a wide range of impedances, sizes and other characteristics, care has been taken in this standard to avoid unnecessarily restrictive standardization but at the same time, wherever feasible, to limit the number of designated standard types.

3. STANDARD TYPES

3.1 Type Designation System

The Type Designation Number shall be determined as follows:

3.1.1 The letters "SDC" shall signify solid and semi-solid dielectric coaxial cables covered by this standard. A dash shall follow.

3.1.2 Two or more digits shall follow, signifying the nominal characteristic impedance in ohms.

3.1.3 When applicable, for two-conductor coaxial cables a letter shall follow, "T" for twin-coaxial cables or "D" for dual-coaxial cables. A dash shall follow.

3.1.4 One or more digits assigned serially shall follow, signifying different sizes and types of coaxial cables which have the same nominal characteristic impedance as a group.

3.1.5 A letter shall follow, signifying the different types of jacket insulation material, "S" for polyvinyl-chloride (PVC) or "P" for fluorinated ethylene propylene (FEP).

3.1.6 When applicable, the letter "A" shall follow, signifying a cable with a protective armor braid.

3.2 List of Standard Coaxial Cables

Coaxial cables covered by this standard are listed in Tables I and II. Performance parameters of these cables are listed in Table III. Materials used in the construction of these cables are covered in Section

4. The tests performed to determine the quality and conformance of these cables to this standard are covered in Section 5.

4. MATERIALS

4.1 Inner Conductors

Tolerances on the inner conductor dimensions shall be rounded out to the next highest .001 inch, unless otherwise specified.

4.1.1 Solid Inner Conductors

4.1.1.1 Bare Copper Wire (B-C)

Bare copper wire shall conform to soft or annealed copper wire, in accordance with ASTM B-3.

4.1.1.2 Tin-Coated Copper Wire (T-C)

Tin-coated copper wire shall conform to tin-coated, soft or annealed copper wire, in accordance with ASTM B-33.

4.1.1.3 Copper-Covered Steel Wire (CWD)

Copper-covered steel wire shall conform to high-strength, 40% conductivity, hard-drawn, copper-covered steel wire, in accordance with ASTM B-227, Grade 40HS. For wires smaller than .0201 inch, the tensile strength shall be 110,000 pounds per square inch (PSI) minimum, the elongation shall be 1% minimum in 10 inches and the thickness of the copper covering shall not be less than 10% of the wire diameter.

4.1.1.4 Annealed Copper-Covered Steel Wire (A-CWD)

Annealed copper-covered steel wire shall conform to the same requirements as copper-covered steel wire as in Section 4.1.1.3, except that it shall be annealed. The tensile strength shall be 55,000 PSI minimum and the elongation shall be 8% minimum in 10 inches.

4.1.1.5 Silver-Coated Wire (S-C, S-CWD, S-A-CWD)

Silver-coated wire shall be coated with 40 microinches minimum thickness of silver, in accordance with ASTM B-298.

4.1.2 Stranded Inner Conductors

Stranded inner conductors shall be concentrically stranded, in accordance with ASTM B-8. Stranded inner conductors shall not be coated after stranding (no over-coating). Individual wires shall meet the requirements of the basic wires.

4.2 Dielectric Cores

Dielectric core material shall be of uniform thickness consistent with the electrical, environmental and dimensional requirements specified. Dielectric core types shall be as specified in Tables I and II.

4.2.1 Solid-Dielectric Cores

Solid dielectric cores shall not contain any air bubbles or voids. There shall be good adhesion between the core and the inner conductor. The inner conductor eccentricity shall not exceed 10% of the core radius.

4.2.2 Semi-Solid (Air-Spaced)-Dielectric Cores

In semi-solid dielectric cores there shall be good adhesion between elements of the core. Air-spaced semi-solid dielectric cores shall be made in such a manner that air spaces are a basic element of the construction.

4.2.3 Dielectric Core Types

Dielectric core materials shall be one of the following types. The dielectric constant and the dissipation factor shall be consistent with the applicable electrical requirements.

4.2.3.1 Types "A"

Polyethylene of the low-density dielectric type.

4.2.3.1.1 Type "A-1"

Solid polyethylene.

4.2.3.1.2 Type "A-2"

Solid polyethylene coated with the best commercial grade of talc, to prevent sticking between individual core materials of two-conductor coaxial cables.

4.2.3.1.3 Type "A-3"

Semi-solid air-spaced polyethylene. One filament thread or a braid of more than one filament thread, within a tube of solid polyethylene, or spiraled fins between tubes of solid polyethylene.

4.2.3.2 Types "F-1"

Solid, Extruded Polytetrafluoroethylene.

4.3 Outer Conductors

Outer conductors shall be braided. Braids shall be applied with the maximum tension possible so as to prevent loosening or creeping, but not to cause broken ends. Braids shall have no irregularities, no breaks or other discontinuities, and no loose un-interwoven strands. There shall be no splices in the completed braid. The individual strands shall meet the applicable requirements of the inner conductor wires. The number of braids shall be as specified in Tables I and II. The percent coverage of the braids shall be determined in accordance with the following formulae:

$$\text{PERCENT COVERAGE} = (2F - F^2) \times 100 \quad F = \frac{N P d}{\sin a} \quad \tan a = \frac{2 \pi (D + 2d) P}{C}$$

Where: D = Maximum outside diameter of the dielectric core under the outer conductor braid. In the case of double braid construction, the diameter (D) for determining the coverage of the outer braid shall be the outside diameter of the inner braid.

d = Diameter of an individual strand of the braid.

N = Number of ENDS (wire strands) per Carrier.

C = Number of CARRIERS (separated groups of Ends) around the diameter of the cable.

P = Minimum number of PICKS PER INCH (separation points between Carriers) along the length of the cable.

a = Smaller angle between the longitudinal axis of the cable and the lay of the outer conductor braid.

For two-conductor cables that are not filled-to-round:

$$\tan a = \frac{2 \pi (D_1 + 2d)P}{C} + \frac{4(D_2 - D_1) P}{C}$$

Where: D₁ = Same as D above, except the minor diameter.

D₂ = Same as D above, except the major diameter.

4.4 Jackets

Jacket materials shall be tough, non-hygroscopic, and cover the cable tightly and evenly in a manner consistent with the mechanical, environmental and dimensional requirements. The jacket material shall be as specified in Tables I and II. Jacket material shall be one of the following types:

4.4.1 Type "S"

Type "S" jackets shall be a non-contaminating type of low-temperature plasticized or

compounded polyvinyl-chloride or vinyl-chloride-vinyl-acetate copolymer (PVC), colored, black.

4.4.2 Type "P"

Type "P" jackets shall be extruded fluorinated ethylene propylene (FEP), colored, brown.

4.5 Armor

Metal armoring shall be a braid construction that is rugged, tough and flexible. Individual braid wires shall be "Alclad 5026" aluminum alloy with a diameter of $.0126 \pm .0005$ inch, a tensile strength of 50,000 PSI minimum, and an elongation of 2% minimum in 10 inches. The percent coverage of the braid shall be 88% minimum, determined as specified in Section 4.3.

4.5.1 Armor Paint

Armor shall be covered with an aluminum paint in paste form, colored, light green.

5. ELECTRICAL AND ENVIRONMENTAL CHARACTERISTICS

5.1 Heat-Aging Stability

The heat-aging stability test is applicable to Jacket Type "S" only. For armored cables, the armor shall be removed before being subjected to the test.

Two specimens shall be subjected to the test. The length of each specimen shall be 150 times the maximum diameter of the cable.

The test specimens shall be suspended in a test oven without touching one another or the walls of the oven. The specimens shall be held at $+98^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for a period of 7 days. Heated air at atmospheric pressure shall be circulated so as to maintain a uniform test temperature.

After the test period, the specimens shall be removed from the test oven and conditioned at room ambient temperature for a period of 4 hours minimum. Examine the specimens for cracks, flaws or other damage.

After the heat aging stability test, the specimens shall be subjected to the cold bend test of Section 5.3.

5.2 Stress-Crack Resistance

The stress-crack-resistance test is applicable to Jacket Type "P" only. For armored cables, the armor shall be removed before being subjected to the test.

Two specimens shall be subjected to the test. The length of each specimen shall be three feet approximately.