



Raychem Wire and Cable

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SPECIFICATION:

64

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WIRE AND CABLE, ELECTRIC, MODIFIED POLYESTER-INSULATED, COPPER OR COPPER ALLOY

1. SCOPE

1.1 SCOPE

This specification covers wire, insulated with extruded, flame retarded, modified polyester. This specification also covers single and multiple conductor cables which may be shielded and jacketed. Cable jackets shall be extruded, flame retarded, modified polyester for the 64 series product line or shall be extruded, modified fluoropolymer (ETFE^{*}) for the 65 series product line. The wire and cable defined by this specification is suitable for general purpose hookup or interconnection applications.

1.2 CLASSIFICATION

Products in accordance with this specification shall be of the following types, as specified in the applicable specification sheet.

Finished Wire: A single conductor, insulated as specified in the applicable specification sheet.

Finished Cable: Any construction other than finished wire, utilizing a wire or wires with or without shielding, and with or without an outer jacket.

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT-FURNISHED DOCUMENTS

The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1.1 Department of Defense

STANDARDS

Federal

FED-STD-228 Cable and Wire, Insulated; Methods of Testing

* Ethylene-tetrafluoroethylene

(Copies of Department of Defense documents may be obtained from the Naval Publications and Forms Center, Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094; or at <http://assist.daps.dla.mil/quicksearch/>.)

2.1.2 Department of Transportation, Federal Aviation Administration

FEDERAL AVIATION REGULATIONS (FAR)

Part 25 Airworthiness Standards: Transport Category Airplanes

(Copies of Department of Transportation, Federal Aviation Administration documents may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402; or at www.faa.gov.)

2.2 OTHER PUBLICATIONS

The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.2.1 American Society for Testing and Materials (ASTM)

B 1 Standard Specification for Hard-Drawn Copper Wire

B 3 Standard Specification for Soft or Annealed Copper Wire

B 33 Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

B 298 Standard Specification for Silver-Coated Soft or Annealed Copper Wire

B 624 Standard Specification for High-Strength, High-Conductivity Copper-Alloy Wire for Electronic Application

D 3032 Standard Test Methods for Hookup Wire Insulation

(Copies of ASTM documents may be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959; or at www.astm.org.)

3. REQUIREMENTS

3.1 SPECIFICATION SHEETS

The requirements for the individual wires and cables furnished under this specification shall be as specified herein and in accordance with the applicable specification sheet. In the event of a conflict, the requirements of the specification sheet shall govern.

3.2 QUALIFICATION

The finished wire and cable furnished under this specification shall be a product which has been tested and has passed the qualification tests specified herein (see 4.3).

3.3 CONSTRUCTION AND MATERIALS

Materials not specifically designated herein shall be of the quality and form best suited for the purpose intended. Unless otherwise specified, the materials shall meet the following requirements:

3.3.1 Conductor Material

Conductor material shall be hard-drawn copper in accordance with ASTM B 1, bare soft or annealed copper in accordance with ASTM B 3, tin-coated soft or annealed copper in accordance with ASTM B 33, silver-coated soft or annealed copper in accordance with ASTM B 298, high-strength copper alloy in accordance with ASTM B 624, or as specified in the applicable specification sheet.

3.3.2 Shield Material

Shield strand material shall be tin-coated soft or annealed copper in accordance with ASTM B 33, or as specified in the applicable specification sheet.

3.3.3 Insulating Materials

3.3.3.1 Finished Wire

Finished wire material shall be an extruded, modified polyester.

3.3.3.2 Cable Jackets

Cable jacket shall be as follows, depending on the product line:

64 cable series = extruded, modified polyester

65 cable series = extruded, modified fluoropolymer (ETFE)

3.3.4 Wraps

Tape wraps, where specified in the applicable specification sheet, shall be applied with an overlap of 25 percent, minimum, and shall meet the material and construction requirements of the applicable specification sheet. Overlap is defined as the percentage of tape width covered by successive turns of tape.

3.4 FINISHED WIRE AND CABLE

3.4.1 Finished Wire

Finished wire shall conform to the requirements of Table 1 and to those of the applicable specification sheet.

TABLE 1. PROPERTIES OF FINISHED WIRE

Examination or Test	Requirement	Test Method	*Inspection Class
Color	Table 2	4.5.5	P
Concentricity	70% min.	ASTM D 3032, Section 16	P
Conductor Elongation	Specification Sheet	4.5.2	V
Conductor Resistance	Specification Sheet	4.5.3	V
Conductor Stranding	Specification Sheet	4.5.5	V
Construction and Materials	Specification Sheet and 3.3	4.5.5	P
Dimensions	Specification Sheet	ASTM D 3032, Section 15	P
Flammability	Specification Sheet	FAR 25.869 (a) (4)	Q
Insulation Elongation	Specification Sheet	4.5.6	P
Insulation Flaws	Specification Sheet	ASTM D 3032, Section 13	100%
Insulation Resistance	Specification Sheet	ASTM D 3032, Section 6	Q
Insulation Tensile Strength	Specification Sheet	4.5.6	Q
Low Temperature-Cold Bend	Specification Sheet and 3.4.5	4.5.7	Q
Mark Durability	3.4.6	4.5.8	P
Temperature Index	3.4.7	ASTM D 3032, Section 14	Q
Weight	Specification Sheet	4.5.9	P
Workmanship	3.4.8	4.5.5	P

*Inspection Class (see 4.2):

P = In-Process or Lot Test

Q = Qualification Test

V = Vendor Test

100% = 100% Finished Product Test

TABLE 2. INSULATION COLORS

Color Code	Solid Color	Target Munsell Designation (Hue/Value/Color)
0	Black	N/2.25/
1	Brown	5YR/5.9/4.3
2	Red	3.3R/3.8/11.0
3	Orange	8.75R/5.75/12.5
4	Yellow	8.2Y/8.5/9.8
5	Green	0.5G/5.6/7.0
6	Blue	9B/5.0/5.0
7	Violet	3.9P/3.4/6.7
8	Gray	N5.7/(10GY,0.2)/
9	White	5Y/9/1

3.4.2 Finished Cable

Finished cable shall conform to the requirements of Table 3 and to those of the applicable specification sheet. Component wires used in the cable shall conform to the requirements of 3.4.1, prior to cabling.

TABLE 3. PROPERTIES OF FINISHED CABLE

Examination or Test	Requirement	Test Method	*Inspection Class
Cabling	3.4.3	4.5.5	P
Conductor and Shield Continuity	3.4.4	4.5.1	100%
Construction and Materials	Specification Sheet and 3.3	4.5.5	P
Dielectric Withstand	Specification Sheet	4.5.4	100%
Dimensions	Specification Sheet	ASTM D 3032, Section 15	P
Flammability	Specification Sheet	FAR 25.869 (a) (4)	Q
Jacket Color	Table 4	4.5.5	P
Jacket Concentricity	70% min.	ASTM D 3032, Section 16	P
Jacket Elongation	Specification Sheet	4.5.6	P
Jacket Flaws	Specification Sheet	ASTM D 3032, Section 13	100%
Jacket Tensile Strength	Specification Sheet	4.5.6	Q
Low Temperature-Cold Bend	Specification Sheet and 3.4.5	4.5.7	Q
Mark Durability	3.4.6	4.5.8	P
Shield Coverage	Specification Sheet	FED-STD-228, Method 8121	P
Weight	Specification Sheet	4.5.9	P
Workmanship	3.4.8	4.5.5	P

*Inspection Class (see 4.2):

P = In-Process or Lot Test

Q = Qualification Test

100% = 100% Finished Product Test

TABLE 4. JACKET COLORS

Color Code	Solid Color	Target Munsell Designation (Hue/Value/Color)
0	Black	2.5G/2/0
1	Brown	10YR/4/3
2	Red	7.5R/5/10
5	Green	5BG/4/4
6	Blue	5PB/3/4
7	Violet	2.5P/4/10
8	Gray	2.5GY/6/1

3.4.3 Cabling

The required number of wires for multiconductor constructions shall be cabled with a left hand lay. The lay of the individual wires shall not be less than eight nor more than sixteen times the outside diameter of the unshielded, unjacketed cable. Fillers and binders shall be used as required.

3.4.4 Conductor and Shield Continuity

When finished cable is tested in accordance with 4.5.1, there shall be no indication of discontinuity in the conductors or shield.

3.4.5 Low Temperature-Cold Bend

When finished wire is tested in accordance with 4.5.7, the insulation shall not crack or fail dielectrically. When finished cable is tested in accordance with 4.5.7, the jacket shall not crack and, if shielded and jacketed, the insulation and jacket shall not fail dielectrically.

3.4.6 Mark Durability

When tested in accordance with 4.5.8, the mark (legend, band, stripe) shall withstand 125 cycles of abrasion without failure. Failure is defined as a continuous line of erasure through the mark.

3.4.7 Temperature Index

The minimum temperature index for AWG 20 wire shall be 10,000 hours at 125°C when tested using the procedure of ASTM D 3032, Section 14. The ASTM designation format for temperature index is *TI* 10 kh/125. Any two temperatures, up to and including 200°C, are suitable for determining the temperature index.

3.4.8 Workmanship

All details of workmanship shall be in accordance with high grade wire and cable manufacturing practices. The insulation and jacket shall be free of cracks, splits, irregularities, and imbedded foreign material.

4. **QUALITY ASSURANCE PROVISIONS**

4.1 RESPONSIBILITY FOR INSPECTION

The supplier is responsible for the performance of all the inspection tests specified herein. The supplier may utilize his own or any other inspection facility and services acceptable to the buyer. Inspection records of the examinations and tests shall be kept complete and available to the buyer as required.

4.2 INSPECTION CLASSIFICATION

- a. Vendor Control (V): Requirements for raw materials such as conductor and insulation materials over which the vendor has control and responsibility.
- b. Process Control (P): Inspections performed on samples taken from the lots of wire or cable. Inspections may be performed on finished wire and cable or after the process which establishes the specified characteristic. The Quality Control Plan establishes the frequency of inspection based on process control data.
- c. One Hundred Percent (100%): Tests performed on the total length of each wire or cable. Tests may be performed on the finished product or "in process", as applicable.
- d. Qualification (Q): Tests performed only at the time of initial qualification or requalification.

4.3 QUALIFICATION INSPECTION

Qualification inspection shall consist of all tests listed in Table 1 for wire and in Table 3 for cable. Requalification testing shall be performed any time changes in materials or processes occur that are deemed to have the potential for significantly altering the form, fit, function, or appearance of the product.

4.3.1 Sampling for Qualification Inspection

Samples of wire or cable for qualification inspection shall be taken from production lots which have been manufactured under the most current Quality Control Plan.

4.4 QUALITY CONFORMANCE INSPECTION

Quality conformance inspection consists of a series of tests and inspections that assure that raw materials and manufacturing processes are consistent and result in products that conform to specification requirements. Quality conformance tests and inspections are listed in Table 1 and Table 3, designated as "P", "V", or "100%", and shall be performed on every lot of wire or cable procured under this specification.

4.5 TEST METHODS

4.5.1 Conductor and Shield Continuity

To establish continuity, 25 volts DC, maximum, shall be applied to both ends of each conductor and shield of the cable through an appropriate indicator, such as an ohmmeter, light, or buzzer. The test voltage may be applied to the conductors and shields individually, or in a series.

4.5.2 Conductor Elongation

Conductor elongation shall be tested in accordance with FED-STD-228, Method 3211, except that the elongation at break of the individual strand or of the first strand of the whole conductor shall be determined by the distance the jaw has traveled. For sizes 20 and larger, the tests shall be performed on individual strands taken from the conductor.

4.5.3 Conductor Resistance

The DC resistance of the conductor shall be measured in accordance with FED-STD-228, Method 6021.

4.5.4 Dielectric Withstand

The voltage specified in the applicable specification sheet shall be applied between each component wire and shield, if any, for a period of 15 to 30 seconds. There shall be no dielectric breakdown.

4.5.5 Examination of Product

All samples shall be examined carefully to determine conformance to this specification and to the applicable specification sheet with regard to requirements not covered by specific test methods.

4.5.6 Insulation or Jacket Elongation and Tensile Strength

4.5.6.1 Qualification

Testing of insulation or jacket elongation and tensile strength shall be performed in accordance with ASTM D 3032, Section 17, with the following conditions and exceptions:

- a) Crosshead speed (jaw separation rate) shall be 2 inches (51 mm) per minute.
- b) Initial jaw separation shall be 1 inch (25 mm).
- c) Suitable adhesive tape may be wrapped on the samples at their point of contact with the jaws to prevent undue pinching of the insulation material.

4.5.6.2 Process Control

Testing of elongation shall be performed in accordance with ASTM D 3032, Section 17, with the following conditions and exceptions:

- a) Crosshead speed (jaw separation rate) shall be 20 inches (508 mm) per minute.
- b) Initial jaw separation shall be 1 inch (25 mm).
- c) One specimen shall be tested.

In the event of a failure under the process control conditions, a referee test shall be performed to the qualification crosshead speed of 2 inches (51 mm) per minute and these results shall take precedence over the process control results.

4.5.7 Low Temperature-Cold Bend

Finished wire and cable shall be tested in accordance with ASTM D 3032, Section 26, at a temperature of $-65 \pm 2^{\circ}\text{C}$, using the voltage as specified in the applicable specification sheet. Finished wire shall be tested on mandrels with a diameter of 15 to 20 times the target diameter of the wire. Finished cable shall be tested on mandrels with a diameter of 25 to 35 times the target, or nominal, diameter of the cable. Test weights shall be sufficient to keep the wire or cable in contact with the mandrel. Jacketed cables without shields are exempt from the voltage withstand test.

4.5.8 Mark Durability

The durability of the mark shall be tested using a General Electric, or equivalent, repeated scrape abrasion tester. The rubbing member shall be a 0.025 inch (0.64 mm) mandrel or needle. The applied load shall be 125 grams.

4.5.9 Weight

The weight of each lot of finished wire or cable shall be determined by Procedure I (4.5.9.1). Lots failing to meet the weight requirement of the applicable specification sheet when tested in accordance with Procedure I shall be subjected to Procedure II (4.5.9.2). All spools or reels failing to meet the requirements of the applicable specification sheet when tested to Procedure II shall be rejected.

4.5.9.1 Procedure I

A length of wire or cable, sufficient to produce a measured weight to at least 3 significant figures, shall be weighed and converted to the weight per unit length shown on the applicable specification sheet.

4.5.9.2 Procedure II

The net weight of the finished wire or cable on each spool or reel shall be obtained by subtracting the tare weight of the spool or reel from the gross weight of the spool or reel containing the finished wire or cable. The net weight of the wire or cable on each spool or reel shall be divided by the accurately determined length of finished wire or cable on that spool or reel and the resultant figure converted to the weight per unit length shown on the applicable specification sheet. When wood or other moisture absorbent materials are used for spool or reel construction, weight determinations shall be made under substantially uniform conditions of relative humidity.

5. **STANDARD PACKAGING**

Unless otherwise specified (see 6.1), the following shall define the standard spooling and labeling requirements for wire and cable furnished under this specification. Standard shipping tolerance on ordered quantity, for both wire and cable, shall be ± 10 percent.

5.1 SPOOLING REQUIREMENTS

All layers of wire and cable shall be wound on spools or reels (see 5.1.3) with sufficient tension to prevent shifting of layers and creation of crossovers within layers.

5.1.1 Finished Wire

Finished wire lengths shall be wound on spools or reels with the ends spliced together to provide one mechanically and electrically continuous length. Unless otherwise specified, the minimum continuous length between splices shall be in accordance with Table 5.

TABLE 5. FINISHED WIRE LENGTHS

Wire Size Range		Minimum Length
(AWG)	(mm ²)	
30 through 10	0.057 through 4.74	100 feet (30 m)
8 and larger	8.60 and larger	50 feet (15 m)

(NOTE: Metric lengths specified above apply only to those orders placed in metric.)

5.1.2 Finished Cable

Finished cable lengths shall be wound on spools or reels with all ends exposed. There shall be no more than 5 lengths per spool or reel and no length shall be less than 50 feet (15 m).

5.1.3 Spools and Reels

Spools and reels shall be of a nonreturnable type. Each spool and reel shall have an appropriate diameter for the respective wire or cable size. In no case shall the barrel of the spool or reel have a diameter less than 3.5 inches (89 mm). Spools and reels shall be suitably finished to prevent corrosion under typical storage and handling conditions. Loaded plastic spools shall not exceed 50 pounds (23 kg). Loaded wooden reels shall have no weight restriction.

5.1.4 Containers

Unless otherwise specified (see 6.1), finished wire and cable shall be delivered in standard commercial containers so constructed as to ensure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery.

5.2 LABELING REQUIREMENTS

All spools and reels shall be identified with the following information:

Manufacturer's Part Number
 Lot Number
 Quantity in Feet (*or Meters*)
 Name of Manufacturer

6. NOTES

6.1 ORDERING DATA

Procurement documents should specify the following:

- Title, number, and revision of this specification
- Applicable specification sheet part number
- Quantity
- Special preparation for delivery requirements, if applicable (see Section 5)

6.2 METRIC UNITS

Metric units (where shown in parentheses) are for information only.

6.3 TRADEMARKS

Raychem, TE Connectivity, TE connectivity (logo), and TE (logo) are trademarks.