



Raychem Wire and Cable

501 Oakside Avenue, Redwood City, CA 94063-3800

SPECIFICATION: 63

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CABLE, ELECTRIC, INSULATED COPPER OR COPPER ALLOY, LOW TENSION - AUTOMATIC TRANSMISSION FLUID RESISTANT

1. SCOPE

1.1 SCOPE

This specification defines cables for automatic transmission applications where the cable is installed within the transmission housing.

1.2 CLASSIFICATION

Products in accordance with this specification shall be of the following type.

Finished Cable: A single stranded wire, insulated as specified in the applicable specification sheet.

2. APPLICABLE 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 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 Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes

B 263 Standard Test Method for Determination of Cross-Sectional Area of Stranded Conductors

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.)

2.2 SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AS4373 Test Methods for Insulated Electric Wire

J1128 Low Voltage Primary Cable

(Copies of SAE documents may be obtained from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001; or at www.sae.org.)

3. REQUIREMENTS

3.1 SPECIFICATION SHEETS

The requirements for the individual 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 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 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, or as specified in the applicable specification sheet.

3.3.2 Insulating Materials

The extruded insulation shall be as specified in the applicable specification sheet.

3.4 FINISHED CABLE

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

TABLE 1. PROPERTIES OF FINISHED CABLE

Examination or Test	Requirement	Test Method	*Inspection Class
Color	3.4.1 and Specification Sheet	Table 2	P
Concentricity	Specification Sheet	ASTM D 3032, Section 16	P
Conductor Resistance	Specification Sheet	SAE AS4373, Method 403	P
Conductor Stranding	Specification Sheet	4.5.2	P
Dielectric Test	3.4.2	SAE J1128	Q
Dimensions	Specification Sheet	ASTM D 3032, Section 15	P
Dynamic Cut-Through	Specification Sheet	ASTM D 3032, Section 22	Q
Flammability	Specification Sheet	SAE J1128	Q
Fluid Tightness	Specification Sheet	4.5.3	P
Heat Resistance	Specification Sheet	4.5.4	Q
Insulation Flaws	Specification Sheet	ASTM D 3032, Section 13	100%
Insulation			
Elongation	Specification Sheet	4.5.5	P
Tensile Strength	Specification Sheet	4.5.5	Q
Insulation Resistance	Specification Sheet	ASTM D 3032, Section 6	Q
Insulation Thickness	Specification Sheet	4.5.2	P
Low Temperature-Cold Bend	3.4.3 and Specification Sheet	4.5.6	Q
Materials	3.3 and Specification Sheet	4.5.1	V
Shrinkage	Specification Sheet	4.5.7	P
Strip Force	Specification Sheet	4.5.8	Q
Thermal Stability	Specification Sheet	4.5.9	Q
Transmission Fluid Resistance			
Diameter Swell	Specification Sheet	4.5.10.1	Q
Mandrel Bend	Specification Sheet	4.5.10.2	Q
Dynamic Cut-Through	Specification Sheet	4.5.10.3	Q
Weight	Specification Sheet	4.5.12	P
Workmanship	3.4.4	4.5.2	P

*Inspection Class (see 4.2):

P = In-Process or Lot Test

Q = Qualification Test

V = Vendor Test

100% = 100% Finished Product Test

3.4.1 Color

Finished cable insulation colors and color code designators shall be as specified in Table 2.

TABLE 2. INSULATION COLORS

Color Code Designators	Solid Color	Target Munsell Designation (Hue/Value/Chroma)	Allowable Range		
			Hue	Value	Chroma
0	Black	10B/2/1	5P-5PB	1-3	0-1
1L	Tan	5YR/5/6	3YR-7YR	4-6	4-8
1	Brown	5YR/3/1	3YR-7.5YR	2-3	1-2
2L	Pink	8.75RP/6/12	7.5RP-9RP	6-7	8-12
2	Red	3.75R/4/12	2.5R-4R	4-5	12-14
3	Orange	10R/5/12	9R-1.25YR	5-6	10-14
4	Yellow	5Y/8/12	2.5Y-7.5Y	8-9	10-14
5L	Light Green	10GY/5/6	8GY-2G	5-6	4-8
5D	Dark Green	10G/3/2	8G-2BG	3-4	1-4
6L	Light Blue	2.5PB/5/6	7.5B-5PB	5-6	4-8
6D	Dark Blue	5PB/3/6	4PB-6PB	2-4	4-8
7	Purple	2.5P/4/10	10PB-5P	3-5	8-12
8	Gray	5PB/6/1	4PB-6PB	5-7	0.8-1.2
9	White	5GY/9/1	5Y-10GY	8.0-9.5	0.8-1.2

3.4.2 Dielectric Test

When finished cable is tested in accordance with SAE J1128, there shall be no dielectric breakdown.

3.4.3 Low Temperature-Cold Bend

When finished cable is tested in accordance with 4.5.6, there shall be no cracking and no dielectric breakdown of the insulation.

3.4.4 Workmanship

All details of workmanship shall be in accordance with high grade wire and cable manufacturing practices. The insulation 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 cable. Inspections may be performed on finished 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 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. 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 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, designated as "P", "V", or "100%", and shall be performed on every lot of cable procured under this specification.

4.5 TEST METHODS

4.5.1 Certification of Materials

Prior to incorporation in a cable construction, incoming (raw) materials must meet internal procurement requirements that are not covered in this specification or the applicable specification sheet. Certificates of compliance shall be kept of file stating that the specified materials have been used and that they met all applicable requirements.

4.5.2 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.

4.5.3 Fluid Tightness

Six samples, 142 ± 2 mm in length shall be prepared. These samples shall be prepared such that one end of each specimen shall be placed in a terminal fitting which would allow water pressure to be applied directly to the exposed cross-sectional area of the ends of the finished cables. Inside the fitting, the specimens have an exposed length of 25 ± 2 mm. The terminal fittings shall then be attached to the water system in which the water pressure is set to 2 psi by a pressure regulator. Any evidence of water leakage constitutes a failure.

4.5.4 Heat Resistance

One inch (25 mm) of insulation shall be removed from each end of a 24-inch (610-mm) sample of finished cable. The central portion of the specimen shall be bent at least halfway around a horizontally positioned smooth teflon coated mandrel of the diameter specified in the applicable specification sheet. Each end of the conductor shall be loaded with the weight specified in the applicable specification sheet so that the portion of the insulation between the conductor and mandrel is under compression while the conductor is under tension. The specimen shall be conditioned for 1 hour at the temperature specified in the applicable specification sheet. After conditioning, the oven shall be shut off, the door opened, and the specimen allowed to cool in the oven for at least one hour. When cool, the specimen shall be freed from tension, removed from the mandrel, and straightened. The compression region of the specimen shall then be bent around the mandrel a minimum of 180° . The specimen shall then be straightened and the opposite surface of the specimen bent in contact with the mandrel. This procedure shall be repeated until two bends in each direction have been formed in the same section of the specimen. The sample shall exhibit no cracking of the insulation or dielectric breakdown when subjected to the voltage withstand test of 4.5.11.

4.5.5 Insulation Elongation and Tensile Strength

4.5.5.1 Qualification

Testing of insulation 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 specimens at their point of contact with the jaws to prevent undue pinching of the insulation material.

4.5.5.2 Quality Conformance

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 quality conformance 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 quality conformance results.

4.5.6 Low Temperature-Cold Bend

Low temperature-cold bend shall be performed in accordance with the Cold Bend test of SAE J1128 for Type SXL for four hours with the test temperature at $-55 \pm 3^{\circ}\text{C}$.

4.5.7 Shrinkage

One 36-inch (*914-mm*) sample of finished cable, while at normal room temperature ($23 \pm 5^{\circ}\text{C}$), shall be cut in half. After 5 minutes, the length of the exposed conductor shall be measured and shall not exceed the value listed in the applicable specification sheet.

4.5.8 Strip Force

Strip force testing shall be performed in accordance with ASTM D 3032, Section 27, with the following conditions and exceptions:

- a. The portion of undisturbed insulation (insulation slug) left on the test specimen shall be 2 inches (*51 mm*).
- b. Tester speed shall be 10 inches (*254 mm*) per minute.
- c. A minimum of three samples shall be tested, and the mean value of the peak (maximum) strip force reported. This value shall equal or exceed the value specified in the applicable specification sheet.

4.5.9 Thermal Stability

A minimum of five tensile specimens shall be prepared in accordance with ASTM D 3032, Section 17. These specimens shall be aged in an air-circulating oven for 168 hours at the temperature specified in the applicable specification sheet. Upon removal from the aging oven, the specimens shall be conditioned at $20 \pm 5^\circ\text{C}$ for a minimum of four hours, and tested for retention of elongation and tensile strength in accordance with 4.5.5.

4.5.10 Transmission Fluid Resistance (Long Term)

Finished cable specimens shall be immersed in the Automatic Trans Fluid specified in SAE J1128, Appendix C, for 720 hours at $150 \pm 2^\circ\text{C}$.

4.5.10.1 Diameter Swell

One 24-inch (610-mm) sample of finished cable shall be prepared for immersion. The specimen shall be immersed to within 1-1/2 inch (38 mm) from the end of the insulation. Upon removal from the test fluid, the specimen shall be blotted with an absorbent tissue and allowed to equilibrate to room temperature for not more than 30 minutes. Afterwards, the diameter of the cable shall be measured in accordance with ASTM D 3032.

Changes in diameter shall be defined as follows and shall not exceed the amount specified in the applicable specification sheet.

$$\% \text{ Change} = 100 \times \frac{(D_1 - D_0)}{D_0}$$

Where: D_1 = post-immersion outer diameter

D_0 = pre-immersion outer diameter

4.5.10.2 Mandrel Bend

One 24-inch (610-mm) sample of finished cable shall be prepared for immersion. The specimen shall be immersed to within 4 inches (102 mm) of the ends of the cable. Upon removal from the test fluids, the specimen shall be blotted with an absorbent tissue and allowed to equilibrate to room temperature for not more than 30 minutes. The 24-inch (610-mm) specimen shall then be wrapped around a mandrel as specified in Table 3 and then wrapped around the mandrel in the opposite direction. The specimen shall show no visible cracking when examined without magnification or dielectric breakdown when tested in accordance with 4.5.11.

TABLE 3. MANDREL DIAMETERS

Wire Size (AWG)	Mandrel (inches)
22	.750
20	1.00
18	1.00
16	1.00
14	1.50

4.5.10.3 Dynamic Cut-Through

One 36-inch (914-mm) sample of finished cable shall be prepared for immersion. From one end of the cable, remove 1 inch (25 mm) of insulation. The specimen shall be immersed to within four inches (102 mm) of the ends of the cable. Upon removal from the test fluid, the specimen shall be blotted with an absorbent tissue and allowed to equilibrate to room temperature for not more than 30 minutes. The specimen shall then be tested to the Dynamic Cut-Through test of ASTM D 3032, Section 22, and shall meet the minimum requirement specified in the applicable specification sheet.

4.5.11 Voltage Withstand (Post Environmental)

One inch (25 mm) of insulation shall be removed from each end of a 24-inch (610-mm) sample of finished cable and the two ends twisted together. The specimen shall be immersed in a 5-percent, by weight, solution of sodium chloride in water at 20 to 25°C, except that the uninsulated ends and 1.5 inches (38 mm) of insulated cable at each end of the specimen shall protrude above the surface of the solution. After immersion for 1 hour, the voltage specified in the applicable specification sheet shall be applied between the conductor and an electrode in contact with the water bath which shall be grounded. The voltage shall be gradually increased at a uniform rate from zero to the specified voltage in 0.5 minute, maintained at that voltage for a period of 1 minute, and gradually reduced to zero in 0.5 minute.

4.5.12 Weight

The weight of each lot of finished cable shall be determined by Procedure I (4.5.13). 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 (4.5.14). All barrels failing to meet the requirements of the applicable specification sheet when tested to Procedure II shall be rejected.

4.5.13 Procedure I

A length of 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 in the applicable specification sheet.

4.5.14 Procedure II

The net weight of the finished cable in each barrel shall be obtained by subtracting the tare weight of the barrel from the gross weight of the barrel containing the finished cable. The net weight of the cable in each barrel shall be divided by the accurately determined length of finished cable in that barrel and the resultant figure converted to pounds per 1000 feet (*kg/km*).

5. STANDARD PACKAGING

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

5.1 PACKAGING REQUIREMENTS

Unless otherwise specified (see 6.1), finished cable shall be supplied in barrels. For any barrel packed shipment of cable, the minimum continuous (unspliced) length shall be 1000 feet (305 m).

5.2 LABELING REQUIREMENTS

All barrels 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:

- a. Title, number, and revision of this specification
- b. Applicable specification sheet part number
- c. Quantity
- d. 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.