



# Standard Specification for Copper-Clad Steel Electrical Conductor for CATV Drop Wire<sup>1</sup>

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## 1. Scope

1.1 This specification covers 21 % conductivity hard-drawn round copper-clad steel wire for coaxial cable center conductors (**Note 1**).

**NOTE 1**—Wire ordered to this specification is not intended for redrawing since it is furnished in the hard-drawn temper. If wire is desired for the purpose, the manufacturer should be consulted.

1.2 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.

## 2. Referenced Documents

2.1 The following documents, of the issue in effect on the date of material purchase, form a part of this specification to the extent referenced herein.

2.2 *ASTM Standards*:<sup>2</sup>

**B193** Test Method for Resistivity of Electrical Conductor Materials

**B258** Specification for Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

2.3 *NIST Document*:<sup>3</sup>

**NBS Handbook 100—Copper Wire Tables**

## 3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

- 3.1.1 Quantity of each size;
- 3.1.2 Wire size: diameter in inches (see **5.1** and **Table 1**);
- 3.1.3 Package size (see **15.1**);
- 3.1.4 Special package marking, if required (Section **15**); and

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

<sup>3</sup> Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, <http://www.nist.gov>.

3.1.5 Place of inspection (**13.2**).

## 4. Material

4.1 The wire shall be composed of a steel core with a substantially uniform and continuous copper cladding thoroughly bonded to it throughout.

4.2 The finished copper-clad steel wire shall conform to the requirements in this specification.

## 5. Dimensions and Permissible Variations

5.1 The size shall be expressed as the diameter of the wire in decimal fractions of an inch, using four places of decimals, that is, in tenths of a mil (**Note 2**).

**NOTE 2**—The values of wire diameters in **Table 1** and **Table 2** are given to the nearest 0.0001 in. (0.0025 mm) and correspond to the standard sizes given in Specification **B258**. In specifying diameters of wire or inspecting wire, the diameter should also be expressed to the fourth decimal place. An excellent discussion of wire gages and related subjects is contained in *NBS Handbook 100*.

5.2 Within the range of diameters included in **Table 1**, the wire shall not vary from the specified diameter by more than  $\pm 1$  %, expressed to the nearest 0.0001 in. (0.0025 mm).

5.3 Ten percent, but not less than five reels (or all, if the lot is less than five), from any lot of wire shall be gaged. All reels shall be gaged if any of the selected reels fail to conform to the requirements for diameter.

## 6. Workmanship, Finish, and Appearance

6.1 The surface of the wire shall be free from imperfections and be consistent with good commercial practice.

## 7. Tensile and Elongation Properties

7.1 The wire shall conform to a minimum tensile requirement of 120 000 psi (827 MPa) and a minimum elongation requirement of 1.0 %.

7.2 Tension tests shall be made on representative samples. Unless otherwise agreed upon between the manufacturer and the purchaser, the elongation shall be determined by measurements made between the jaws of the testing machine. The zero length shall be the distance between the jaws when a load equal to 10 % of the specified tensile strength has been applied, and the final length shall be the distance between the jaws at the time of rupture. The zero length shall be as near 10 in. (254

**TABLE 1 Properties of Hard-Drawn 21 % Conductivity Copper-Clad Steel Wire**

Nominal Diameter, in. <sup>A</sup>	Permissible Variations <sup>A</sup>	Maximum Resistance /1000 ft at 20°C	Minimum Copper Thickness, in. <sup>A</sup>
0.0641	±0.0006 in.	12.249	0.00096
0.0571	±0.0006 in.	15.472	0.00086
0.0508	±0.0005 in.	19.521	0.00076
0.0453	±0.0005 in.	24.608	0.00068
0.0403	±0.0004 in.	31.024	0.00060
0.0320	±0.0003 in.	49.150	0.00048
0.0285	±0.0003 in.	62.107	0.00043

<sup>A</sup> Metric equivalents: 1 in. = 25.4 mm.

**TABLE 2 Approximate Properties (Information Only)**

Nominal Diameter, in. <sup>A</sup>	Area		Rated Breaking Strength, min, lb	Mass (lb/1000 ft)	Mass (lb/mile)
	cmil	in. <sup>2A</sup>			
0.0641	4108	0.003227	387	11.10	58.60
0.0571	3260	0.002560	307	9.05	47.78
0.0508	2580	0.002026	243	6.99	36.90
0.0453	2052	0.001611	193	5.56	29.36
0.0403	1624	0.001276	153	4.51	23.81
0.0320	1024	0.000804	96	2.77	14.65
0.0285	812	0.000637	75	2.25	11.88

<sup>A</sup> Metric equivalents: 1 in. = 25.4 mm; 1 in.<sup>2</sup> = 645.16 mm<sup>2</sup> (round to four significant figures); 1 mil = 0.0254 mm (round to two decimal places).

mm) as practicable. The fracture shall be between the jaws of the testing machine and not closer than 1 in. (25.4 mm) to either jaw. The elongation as thus determined shall not be less than 1.0 %. See **Table 2** for related breaking strengths.

7.3 When agreed upon between the manufacturer and the purchaser, the elongation may be measured by means of an extensometer suitable for measuring elongation in 10 in. (250 mm) and having a vernier reading to 0.01 in. (0.25 mm) attached to the test specimen at a tension load of approximately 10 % of rated strength. The elongation as thus determined shall not be less than 1.0 %. If the fracture occurs before the 1.0 % elongation requirement and outside the two attachments of the extensometer to the specimen, this sample shall be disregarded and a retest shall be performed.

7.4 *Retest*—If, upon testing a sample from any coil or spool of wire, the results do not conform to the tensile requirements prescribed in **7.1** and the elongation requirements of **7.4**, two additional samples shall be tested, and the average of the three tests shall determine the acceptance or rejection of the coil or spool.

NOTE 3—The approximate properties of 21 % conductivity hard drawn copper-clad steel wire are shown in **Table 1** for the information of the user of this specification.

## 8. Torsion Test

8.1 The wire shall withstand, without fracture, not less than 20 torsions in a length equivalent to 100 times the nominal diameter of the specimen. In the twist test, the rate of applying the twists shall be approximately 15/min.

8.2 Specimens shall be twisted to destruction and shall not reveal under testing any seams, pits, slivers, or surface imper-

fections of sufficient magnitude to indicate inherent defects or imperfections in the wire.

8.2.1 Examination of the wire at the break shall show no separation of copper from the steel.

## 9. Resistance

9.1 The electrical resistance of the wire (**Note 4**) shall be determined by resistance measurements, and maximum resistance shall be based on the minimum diameter of the wire and resistivity value at 20°C Ω cmil/ft of 49.39. This is to correspond to a minimum conductivity of 21 % IACS.

NOTE 4—Electrical resistance is calculated by the following equation:

$$\text{maximum resistance } (\Omega/\text{ft}) = \frac{\text{resistivity, } \Omega \times \text{circular mil/ft}}{(\text{minimum diameter, mil})^2}$$

9.2 The maximum resistance values are given in **Table 1**.

9.3 When resistance measurements are made at temperatures other than 20°C, corrections shall be based on a temperature coefficient of resistance of 0.0038/°C.

9.4 Tests to determine conformance to the electrical resistance requirements of **Table 1** shall be made in accordance with Test Method **B193**.

## 10. Uniformity of Copper Cladding

10.1 At no point around the circumference of the wire should the copper thickness be less than that shown in **Table 1**. The minimum copper thickness expressed as a percent of the wire size shall be 1.5 % of the wire diameter or 0.015 times the diameter. The minimum copper thickness may be determined by direct measurements of the cross section of the wire or by means of a suitable electrical indicating instrument operating on the permeameter principle. Direct measurement shall be taken from the ends of the coils for referee purposes.

## 11. Joints

11.1 There shall be no joints of any kind made in the finished wire.

11.2 Joints may be made in the rods or semifinished wires prior to drawing to final size in accordance with good commercial practice.

## 12. Density

12.1 For the purpose of calculating mass/unit length, cross section, and so forth, the density of the wire shall be taken as 0.28807 lb/in.<sup>3</sup> (7.98 g/cm<sup>3</sup>) at 20°C (see **Table 2**).

## 13. Inspection

13.1 Unless otherwise specified in the contract or purchase order, the manufacturer shall be responsible for the performance of all inspection and test requirements specified.

13.2 All inspections and tests shall be performed at the place of manufacture unless otherwise especially agreed upon between the manufacturer and the purchaser at the time of the purchase.

13.3 The manufacturer shall afford the inspector representing the purchaser all reasonable manufacturer's facilities necessary to ensure that the material is being furnished in accordance with this specification.

#### **14. Certification**

14.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser showing that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

#### **15. Packaging and Package Marking**

15.1 Package sizes shall be agreed upon between the manufacturer and the purchaser in the placing of individual purchase orders.

15.2 The wire shall be protected from damage in ordinary handling and shipping.

15.3 Each reel shall bear a tag showing the manufacturer's name or trademark, size, and minimum conductivity of the material. If additional information is to be required on the tags, it shall be arranged with the manufacturer at the time of purchase.

#### **16. Keywords**

16.1 center conductor CATV; clad steel electrical conductor; copper electrical conductor-copper-clad steel; copper-clad steel electrical conductor; electrical conductor; hard drawn copper-clad steel wire; steel wire-copper-clad CATV

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