Designation: B452 – 02

Standard Specification for Copper-Clad Steel Wire for Electronic Application[1]

This standard is issued under the fixed designation B452; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers bare round copper-clad steel wire for electronic application.

1.2 Four classes of copper-clad steel wire are covered as follows:

1.2.1 *Class 30HS*—Nominal 30 % conductivity hard-drawn,

1.2.2 *Class 30A*—Nominal 30 % conductivity annealed,

1.2.3 *Class 40HS*—Nominal 40 % conductivity hard-drawn, and

1.2.4 *Class 40A*—Nominal 40 % conductivity annealed.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are in SI units.

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:* [2]

B193 Test Method for Resistivity of Electrical Conductor Materials [2]

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

2.3 *National Institute of Standards and Technology:*

NBS *Handbook 100—Copper Wire Tables*[3]

3. Ordering Information

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

3.1.1 Quantity of each size and class,

3.1.2 Wire size, diameter in inches (see 5.3 and Table 1),

3.1.3 Class of wire (see 1.2 and Table 1),

3.1.4 Packaging and shipping (Section 10),

3.1.5 If inspection is required (see 6.3.3), and

3.1.6 Place of inspection (see 6.1).

4. Material

4.1 The wire shall consist of a core of homogeneous open-hearth, electric-furnace, or basic-oxygen steel with a continuous outer cladding of copper thoroughly bonded to the core throughout and shall be of such quality as to meet the requirements of this specification (Note 1).

NOTE 1—The copper-clad steel wire provides a high-strength conductor for use in wire and cable where greater strength is required and a lower conductivity can be tolerated. At high frequencies the reduced conductivity is less pronounced due to concentration of the current in the outer periphery of the wire. Minimum thickness of 6 % and 10 % of the radius for 30 and 40 % conductivity material, respectively, has been established to facilitate the inspection of thickness on fine wires.

5. General Requirements

5.1 *Tensile Strength and Elongation*—The copper-clad steel wire shall conform to the tensile strength and elongation requirements of Table 1. For intermediate sizes not listed in Table 1, the elongation requirements of the next smaller size shall apply; in the case of tensile strength, the requirements of the next larger size shall apply.

5.2 *Resistivity*—The electrical resistivity at a temperature of 20°C shall not exceed the values prescribed in Table 2. See Note 2 for calculating electrical resistance.

NOTE 2—Relationships which may be useful in connection with the values of electrical resistivity prescribed in this specification are shown in Table 3. Resistivity units are based on the International Annealed Copper Standard (IACS) adopted by IEC in 1913, which is 1⁄58 $\Omega\cdot mm^2/m$ at 20°C for 100 % conductivity. The value of 0.017241 $\Omega\cdot mm^2/m$ and the value of 0.15328 $\Omega\cdot g/m^2$ at 20°C are respectively the international equivalent of volume and weight resistivity of annealed copper equal to 100 % conductivity. The latter term means that a copper wire 1 in. in length and weighing 1 g would have a resistance of 0.15328 Ω. This is equivalent to

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[2] *Annual Book of ASTM Standards*, Vol 02.03.

[3] Available from the National Institute of Standards and Technology (NIST), Gaithersburg, MD 20899.

TABLE 1 Tensile and Elongation Requirements

Diameter		Cross-Sectional Area at 20°C			Tensile Strength, psi (kgf/mm²)				Elongation, min. % in 10 in. (250 mm)	
in.	mm	cmil	in.²	mm²	Class 30HS, min	Class 30A, min	Class 40HS, min	Class 40A, min	Class 30HS and 40HS	Class 30A and 40A
0.0720	1.83	5180	0.00407	2.63	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.5	15
0.0641	1.63	4110	0.00323	2.08	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.5	15
0.0571	1.45	3260	0.00256	1.65	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.5	15
0.0508	1.29	2580	0.00203	1.31	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.5	15
0.0453	1.15	2050	0.00161	1.04	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.5	15
0.0403	1.02	1620	0.00128	0.823	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.0	15
0.0359	0.912	1290	0.00101	0.653	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.0	15
0.0320	0.813	1020	0.000804	0.519	127 000 (89.3)	50 000 (35.2)	110 000 (77.3)	45 000 (31.6)	1.0	15
0.0285	0.724	812	0.000638	0.412	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	15
0.0253	0.643	640	0.000503	0.324	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	15
0.0226	0.574	511	0.000401	0.259	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	15
0.0201	0.511	404	0.00317	0.205	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0179	0.455	320	0.000252	0.162	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0159	0.404	253	0.000199	0.128	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0142	0.361	202	0.000158	0.102	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0126	0.320	159	0.000125	0.0804	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0113	0.287	128	0.000100	0.0647	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0100	0.254	100	0.0000785	0.0507	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0089	0.226	79.2	0.0000622	0.0401	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0080	0.203	64.0	0.0000503	0.0324	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0071	0.180	50.4	0.0000396	0.0255	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0063	0.160	39.7	0.0000312	0.0201	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0056	0.142	31.4	0.0000246	0.0159	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0050	0.127	25.0	0.0000196	0.0127	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0045	0.114	20.2	0.0000159	0.0103	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0040	0.102	16.0	0.0000126	0.00811	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0035	0.089	12.2	0.00000962	0.00621	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10
0.0031	0.079	9.61	0.00000755	0.00487	127 000 (89.3)	55 000 (38.7)	110 000 (77.3)	50 000 (35.2)	1.0	10

TABLE 2 Resistivity, max, at 20°C

Class of Wire	Ω·mm²/m
30HS and 30A	0.05862 (0.058616)
40HS and 40A	0.04397 (0.043970)

a resistivity value of 875.20Ω· lb/mile², which signifies the resistance of a copper wire 1 mile in length weighing 1 lb. It is also equivalent, for example, to 1.7241 μΩ/cm of length of a copper bar 1 cm² in cross section. A complete discussion of this subject is contained in *NBS Handbook 100*. The use of five significant figures in expressing resistivity does not imply the need for greater accuracy of measurement than that specified in Test Method B193. The use of five significant figures is required for complete reversible conversion from one set of resistivity units to another.

5.3 *Dimensions and Permissible Variations*—The wire sizes shall be expressed as the diameter of the wire in decimal fractions of an inch to the nearest 0.0001 in. (0.003 mm) (Note 3). For diameters under 0.0100 in. (0.254 mm), the wire shall not vary from the specified diameter by more than ±0.0001 in. (0.003 mm) and for diameters of 0.0100 in. (0.254 mm) and over, the wire shall not vary from the specified diameter by more than ±1 %, expressed to the nearest 0.0001 in. (0.003 mm).

NOTE 3—The values of the wire diameters in Table 1 are given to the nearest 0.0001 in. (0.003 mm) and correspond to the standard sizes given in Specification B258. The use of gage numbers to specify wire sizes is not recognized in this specification because of the possibility of confusion. An excellent discussion of wire gages and related subjects is contained in *NBS Handbook 100.*

5.4 *Adhesion and Other Defects*—The copper-clad steel wire, when tested in accordance with 7.4, shall not reveal any seams, pits, slivers, or other imperfection of sufficient magnitude to indicate inherent defects or imperfections. Examination of the wire at the break with the unaided eye (normal spectacles excepted) shall show no separation of copper from the steel.

5.5 *Joints*—Necessary joints in the wire and rods prior to final drawing shall be made in accordance with good commercial practice. The finished wire shall contain no joints or splices made at finished size.

5.6 *Finish*—The wire shall be free from copper discontinuities and all imperfections not consistent with good commercial practice (see 7.5).

5.7 *Copper Thickness*—The minimum copper thickness due to eccentricity shall be not less than the following:

5.7.1 The 30 % conductivity wire shall have a minimum thickness of not less than 6 % of the wire radius.