Designation: B 566 – 93 (Reapproved 1998)$^{\epsilon 1}$

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Specification for Copper-Clad Aluminum Wire[1]

This standard is issued under the fixed designation B 566; 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.

ϵ^1 NOTE—Editorial changes were made throughout in March 1998.

1. Scope

1.1 This specification covers bare round copper-clad aluminum wire for electrical applications.

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

Class 10A—Nominal 10 volume % copper, annealed.
Class 15A—Nominal 15 volume % copper, annealed.
Class 10H—Nominal 10 volume % copper, hard-drawn.
Class 15H—Nominal 15 volume % copper, hard-drawn.

1.3 The values stated in inch-pound units are to be regarded as the standard, except for resistivity and density, where the SI units are the standard. The values given in parentheses are for information only.

2. Referenced Documents

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

2.2 *ASTM Standards:*

B 193 Test Method for Resistivity of Electrical Conductor Materials[2]

B 258 Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors[2]

2.3 *National Institute of Standards and Technology:*

NBS Handbook 100—Copper Wire Tables[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—a lot is any amount of wire of one class and size presented for acceptance at one time; such amount, however, not to exceed 100 production units.

3.1.2 *sample*—a quantity of production units (coils, reels, etc.) selected at random from the lot for the purpose of determining conformance of the lot to the requirements of this specification.

3.1.3 *specimen*—a length of wire removed for test purposes from any individual production unit of the sample.

4. Ordering Information

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

4.1.1 Quantity of each size and class.

4.1.2 Wire size, diameter in inches (see Section 7 and Table 1).

4.1.3 Class of wire (see 1.2 and Table 1).

4.1.4 Packaging and shipping (Section 14 and packaging inspection if required, 13.1).

4.1.5 Place of inspection (see 13.1).

5. Materials and Manufacture

5.1 The wire shall consist of a core of aluminum 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.

6. General Requirements

6.1 *Tensile Strength and Elongation*—The copper-clad aluminum wire shall conform to the tensile strength and elongation requirements of Table 1. For intermediate diameters 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.

6.2 *Resistivity*— The electrical resistivity at a temperature of 20°C shall not exceed the values prescribed in Table 2. See Note 1 for calculating electrical resistance.

NOTE 1—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 Ω·mm^2/m and the value of 0.15328 Ω·g/m ^{2} at 20°C are respectively the international equivalent of volume and weight resistivity of annealed copper equal to 100 % conductivity. The later term means that a copper wire 1 m in length and weighing 1 g would have a resistance of 0.15328 Ω. This is equivalent to a resistivity value of 875.20 Ω·lb/mile^2, 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 cm^2 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 B 193. The use of five significant figures is required for complete

[1] This specification is under the jurisdiction of ASTM Committee B-1 on Electrical Conductors and is the direct responsibility of Subcommittee B01.06 on Composite Conductors.

Current edition approved July 15, 1993. Published September 1993. Originally published as B 566 – 72. Last previous edition B 566 – 88 (1993)$^{\epsilon 1}$.

[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 for Copper-Clad Aluminum Wire

Nominal Diameter		Tensile Strength				Elongation, min, % in 10 in. (or 250 mm)	
		Minimum All H Classes		Maximum All A Classes		All H Classes	All A Classes
in.	(mm)	ksi	(MPa)	ksi	(MPa)		
0.0349	8.252	16	110	20	138	1.5	15
0.2893	7.348	16	110	20	138	1.5	15
0.2576	6.543	18	124	20	138	1.5	15
0.2294	5.827	20	138	20	138	1.5	15
0.2043	5.189	22	152	20	138	1.5	15
0.1819	4.620	23	159	20	138	1.5	15
0.1620	4.115	24	166	20	138	1.5	15
0.1443	3.665	25	172	20	138	1.5	15
0.1285	3.264	26	179	20	138	1.0	15
0.1144	2.906	27	186	20	138	1.0	15
0.1019	2.588	28	193	20	138	1.0	15
0.0907	2.30	29	200	20	138	1.0	15
0.0808	2.05	30	207	20	138	1.0	15
0.0720	1.83	30	207	20	138	1.0	15
0.0641	1.63	30	207	20	138	1.0	15
0.0571	1.45	30	207	20	138	1.0	15
0.0508	1.29	30	207	20	138	1.0	15
0.0453	1.15	30	207	20	138	1.0	15
0.0403	1.02	30	207	20	138	1.0	15
0.0359	0.912	30	207	20	138	1.0	15
0.0320	0.813	30	207	20	138	1.0	15
0.0285	0.724	30	207	20	138	1.0	15
0.0253	0.643	30	207	20	138	1.0	15
0.0226	0.574	30	207	25	172	1.0	10
0.0201	0.511	30	207	25	172	1.0	10
0.0179	0.455	30	207	25	172	1.0	10
0.0159	0.404	30	207	25	172	1.0	10
0.0142	0.361	30	207	25	172	1.0	10
0.0126	0.320	30	207	25	172	1.0	5
0.0113	0.287	30	207	25	172	1.0	5
0.0100	0.254	30	207	25	172	1.0	5
0.0089	0.226	30	207	25	172	1.0	5
0.0080	0.203	30	207	25	172	1.0	5
0.0071	0.180	30	207	25	172	1.0	5
0.0063	0.160	30	207	25	172	1.0	5
0.0056	0.142	30	207	25	172	1.0	5
0.0050	0.127	30	207	25	172	1.0	5

TABLE 2 Resistivity

Resistivity, max, at 20°C	
Class of Wire	Ω·mm²/m
10A and 10H	0.02743
15A and 15H	0.02676

reversible conversion from one set of resistivity units to another.

6.3 *Cohesion*—The copper-clad aluminum wire, when tested in accordance with 10.4, shall be free from seams or splits. Examination of the wire shall be made at a magnification not to exceed 10×.

6.4 *Adhesion*—The copper-clad aluminum wire, when tested in accordance with 10.5, shall be free from cladding delamination not consistent with good commercial practice. Examination of the wire shall be made at a magnification not to exceed 10×.

6.5 *Joints*—The finished wire shall contain no joints or splices.

6.6 *Copper Thickness*— The minimum copper thickness, when tested in accordance with 10.6, shall be not less than the following:

6.6.1 Class 10A and 10H wire shall have a minimum thickness of not less than 3.5 % of the wire radius.

6.6.2 Class 15A and 15H wire shall have a minimum thickness of not less than 5.0 % of the wire radius.

6.7 *Copper Volume (Area)*—The copper volume (area) per class, when tested in accordance with 10.6, shall meet the following tolerances:

6.7.1 Class 10A and 10H wire shall contain not less than 8 % and not more than 12 % copper by volume (area).

6.7.2 Class 15A and 15H wire shall contain not less than 13 % and not more than 17 % copper by volume (area).

7. Dimensions, Mass and Permissible Variations

7.1 The wire size 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 2). 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 2—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 B 258. The use of gage numbers to specify wire sizes is not recognized in this specification because of the possibility of confusion. A discussion of wire gages and related subjects is contained in "Copper Wire Tables," *NBS Handbook 100.*

8. Workmanship, Finish, and Appearance

8.1 The wire, when tested in accordance with 8.2, shall be free from pits, slivers, exposed aluminum, or other imperfections not consistent with good commercial practice.

8.2 For wire diameters of 0.0720 in. (1.829 mm) and larger, surface finish inspection shall be made with the unaided eye (normal spectacles excepted) and for wire diameters smaller than 0.0720 in., surface finish inspection shall be made at a magnification not to exceed 10×.

9. Sampling

9.1 The number of production units in a sample shall be as follows:

9.1.1 For tensile strength, elongation, resistivity, adhesion, cohesion, and dimensional measurements, the sample shall consist of a quantity of production units shown in Table 4 under heading "First Sample." From each unit, one test specimen of sufficient length shall be removed for the performance of the required tests.

9.1.2 For surface finish and packaging inspection (when specified by the purchaser at the time of placing the order), the sample shall consist of a quantity of production units as shown in Table 5.

10. Test Methods

10.1 *Tensile Strength and Elongation*—The tensile strength, expressed in pounds-force per square inch (or megapascals),