Designation: ~~B501 – 10~~ B501 – 10 (Reapproved 2015)

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

This standard is issued under the fixed designation B501; 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 U.S. Department of Defense.

1. Scope

1.1 This specification covers silver-coated, round, copper-clad steel wire for electronic application.

1.2 Silver coatings in mass percentages of the total mass of the coated wire are as follows: 1.25, 2.5, 4.0, 6.1, and 8.0.

1.2.1 Silver-coated wire having different minimum percentage of silver by mass may be obtained by mutual agreement between the manufacturer and the purchaser. For information purposes, the thickness of coating in microinches provided by the mass percentages listed in 1.2 is shown in Table 1.

1.3 Four classes of copper-clad steel wire are covered as follows: Class 30HS nominal 30 % conductivity hard-drawn, Class 30A nominal 30 % conductivity annealed, Class 40HS nominal 40 % conductivity hard-drawn, and Class 40A nominal 40 % conductivity annealed.

1.4 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.

1.4.1 *Exception*—In resistivity the SI units are to be regarded as the standard

1.5 The following safety hazards caveat pertains to the test method described in this specification. *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* (~~**Caution—Caution**~~~~Consideration~~—Consideration should be given to toxicity and flammability when selecting solvent ~~cleaners.)~~cleaners.)

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:*[2]

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

B452 Specification for Copper-Clad Steel Wire for Electronic Application

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—any amount of wire of one class and size presented for acceptance at one time, such amount, however, not to exceed 10 000 lb (4500 kg) (Note 1).

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

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

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the ~~standard's~~standard's Document Summary page on the ASTM website.

TABLE 1 Silver Mass Percent and Thickness of Coating

Diameter		Cross-Sectional Area at 20°C			Thickness of Silver, µin. (for information only)				
in.	mm	cmil	$in.^2$	mm^2	1.25 %	2.5 %	4.0 %	6.1 %	8.0 %
0.0720	1.829	5 180	0.00407	2.63	176	352	569	876	1 158
0.0641	1.628	4 110	0.00323	2.08	156	313	507	779	1 031
0.0571	1.450	3 260	0.00256	1.65	139	279	451	694	918
0.0508	1.290	2 580	0.00203	1.31	124	248	401	618	817
0.0453	1.151	2 050	0.00161	1.04	111	222	358	551	728
0.0403	1.024	1 620	0.00128	0.823	98	197	318	490	648
0.0359	0.912	1 290	0.00101	0.653	88	176	284	437	577
0.0320	0.813	1 020	0.000804	0.519	78	156	253	389	515
0.0285	0.724	812	0.000638	0.412	70	139	225	347	458
0.0253	0.643	640	0.000503	0.324	62	124	200	308	407
0.0226	0.574	511	0.000401	0.259	55	111	179	275	363
0.0201	0.511	404	0.000317	0.205	49	98	159	244	323
0.0179	0.455	320	0.000252	0.162	44	88	141	218	288
0.0159	0.404	253	0.000199	0.128	39	78	126	193	256
0.0142	0.361	202	0.000158	0.102	35	69	112	173	228
0.0126	0.320	159	0.000125	0.0804	31	62	100	153	203
0.0113	0.287	128	0.000100	0.0647	28	55	89	137	182
0.0100	0.254	100	0.0000785	0.0507	24	49	79	122	161
0.0089	0.226	79.2	0.0000622	0.0401	22	44	70	108	143
0.0080	0.203	64.0	0.0000503	0.0324		39	63	97	129
0.0071	0.180	50.4	0.0000396	0.0255		35	56	86	114
0.0063	0.160	39.7	0.0000312	0.0201		31	50	77	101
0.0056	0.142	31.4	0.0000246	0.0159		26	44	68	90
0.0050	0.127	25.0	0.0000196	0.0127		24	40	61	80
0.0045	0.114	20.2	0.0000159	0.0103		22	36	55	72
0.0040	0.102	16.0	0.0000126	0.00811			32	49	64
0.0035	0.089	12.2	0.00000962	0.00621			28	43	56
0.0031	0.079	9.61	0.00000755	0.00487			24	38	50

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

NOTE 1—A lot should comprise material taken from a product regularly meeting the requirements of this specification. Inspection of individual lots of less than 500 lb (250 kg) of wire cannot be justified economically. For small lots of 500 lb (250 kg) or less, the purchaser may agree to the manufacturer's regular inspection of the product as a whole as evidence of acceptability of such small lots.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:
4.1.1 Quantity of each size,
4.1.2 Wire size (see 7.1 and Table 1),
4.1.3 Class of basis wire (see 1.3),
4.1.4 Mass percentage of coating (see 1.2 and Table 1),
4.1.5 Package size (see Section 12),
4.1.6 Special packaging marking, if required, and
4.1.7 Place of inspection (see 9.1).

5. Materials and Manufacture

5.1 The basis material shall consist of copper-clad steel wire conforming to the product description, quality and specification requirements of Specification B452.

5.2 The silver-coated wire shall consist of the basis wire coated with silver. The quality of the silver-coated wire shall be such that the finished product meets the properties and requirements in this specification (Note 2).

NOTE 2—Silver coatings on copper-clad steel provide for:
(*a*) A barrier between the copper and insulation whose curing temperature in the process of fabricating is too high for the use of tin-coated wires.
(*b*) A low contact resistance between the strands of outer conductors of coaxial conductors used in high-frequency circuits.
(*c*) A low radio-frequency resistance of conductors used in high-frequency circuits (skin effect).
(*d*) Good solderability for high-temperature hook-up wires which prohibit the use of tin-coated wires due to high curing temperatures used in fabricating the finished wire.

6. General Requirements

6.1 Tensile strength and elongation of the silver-coated wire shall conform to the requirements of Specification B452 for the applicable size and class of copper-clad steel wire.

6.2 *Resistivity*—The electrical resistivity at a temperature of 20°C shall not exceed the values prescribed in Table 2. See Note 3 for calculating electrical resistance.

6.3 *Continuity of Coating*—The coating shall be continuous. The continuity of the coating shall be determined on representative samples taken before stranding or insulating and shall be determined by the sodium polysulfide test, in accordance with 10.2.3.1. Wire whose coating mass corresponds to a thickness less than 0.00005 in. (50 µin.) shall not be subject to this test.

6.4 *Mass of Coating*—The mass of coating expressed in percent of the total mass of the wire shall be not less than the percentage specified and referred to in this specification or the percentage as agreed on between the manufacturer and purchaser at the time of the placing of the order. For ease of comparison, the thickness of coating for various percentages has been included in Table 1.

6.5 *Joints*—Necessary joints in the wire and rods prior to final coating and drawing shall be made in accordance with good commercial practice. Joints made after coating shall not be allowed to remain in the final product.

TABLE 3 Sampling for Dimensional Measurements

No. of Units in Lot	First Sample		Second Sample		
	No. of Units in Sample n_1	Allowable No. of Defects in Sample c_1	No. of Units in Sample n_2	$n_1 + n_2$	Allowable No. of Defects in both Samples, c_2
1 to 14, incl	all	0	...	...	0
15 to 50, incl	14	0	...	...	0
51 to 100, incl	19	0	23	42	1
101 to 200, incl	24	0	46	70	2
201 to 400, incl	29	0	76	105	3
401 to 800, incl	33	0	112	145	4
Over 800	34	0	116	150	4

NOTE 3—Relationships which may be useful in connection with the values of electrical resistivity prescribed in this specification are shown in Table 2. Resistivity units are based on the International Annealed Copper Standard (IACS) adopted by IEC in 1913, which is 1/58 Ω·mm²/m at 20°C for 100 % conductivity. The values of 0.017241 Ω·mm²/m and the value of 0.15328 Ω·g/m² at 20°C are respectively the international equivalent of volume and mass resistivity of annealed copper equal to 100 % conductivity. The latter term means that a copper wire 1 m in length and mass of 1 g would have a resistance of 0.15328 Ω. This is equivalent to a resistivity value of 875.20 Ω·lb/mile², which signifies the resistance of a copper wire 1 mile in length with mass of 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* of the National Institute of Standards and Technology. 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.

7. Dimensions and Permissible Variations

7.1 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 4). 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 4—The values of the wire diameters in Table 1 are given to the nearest 0.0001 in. and correspond to the standard sizes given in Specification B258. The use of gage numbers to specify wires 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*[3] of the National Institute of Standards and Technology.

8. Workmanship, Finish, and Appearance

8.1 The coating shall consist of a smooth, continuous layer, firmly adherent to the surface of the copper. The wire shall be bright and free from all imperfections not consistent with good commercial practice.

[3] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop ~~3460,~~1070, Gaithersburg, MD ~~20899-3460.~~20899-1070, http://www.nist.gov.

TABLE 2 Resistivity

Resistivity, max at 20°C	
Class of Wire	Ω·mm²/m
30HS and 30A	0.05862
40HS and 40A	0.04397