Designation: ~~B286 – 07 (Reapproved 2017)~~ B286 – 20

Standard Specification for Copper Conductors for Use in Hookup Wire for Electronic Equipment[1]

This standard is issued under the fixed designation B286; 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 uninsulated metallic-coated copper conductors for use in hookup wire for electronic equipment.

1.2 The SI values for density are to be regarded as standard. For all other properties, the inch-pound values are to be regarded as the standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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]

B33 Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
B189 Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
B193 Test Method for Resistivity of Electrical Conductor Materials
B258 Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors
B298 Specification for Silver-Coated Soft or Annealed Copper Wire
B355 Specification for Nickel-Coated Soft or Annealed Copper Wire

3. Ordering Information

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

3.1.1 Quantity of each size, designation (Table 1) and type,

[1] This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.04 on Conductors of Copper and Copper Alloys.

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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 Document Summary page on the ASTM website.

TABLE 1 Details of Conductor Construction

Type I (Solid Conductors)

Size Designation, AWG	Nominal Area, cmils	Nominal Diameter, in.	D-C Resistance at 20°C, Ω/1000 ft, max (Explanatory Note 2)				
			Annealed Tin or Lead-Alloy Coated	Annealed Silver Coated	Class 2 Nickel[A]	Class 10 Nickel	Class 27 Nickel
10	10380	0.1019	1.06	1.02	1.05	1.17	1.44
12	6530	0.0808	1.69	1.62	1.68	1.84	2.28
14	4110	0.0641	2.68	2.58	2.67	2.93	3.63
16	2580	0.0508	4.26	4.10	4.27	4.65	5.77
18	1620	0.0403	6.78	6.52	6.79	7.39	9.17
20	1020	0.0320	10.7	10.3	10.8	11.8	14.6
22	640	0.0253	17.2	16.5	17.3	18.8	23.3
24	404	0.0201	27.2	26.2	27.3	29.8	36.9
26	253	0.0159	44.5	41.9	43.8	47.5	58.9
28	159	0.0126	70.8	66.8	69.4	75.4	107.0
30	100	0.0100	114.0	106.0	110.0	120.0	149.0

Type II (Stranded Conductors)

Size Designation[B]	Conductor Construction					D-C Resistance at 20°C, Ω/1000 ft, max (Explanatory Note 2)				
	Number of Wires[C]	Nominal Diameter of Each Wire, in.	Calculated Cross-Sectional Area, cmils	Maximum Allowable Diameter, in.[D]	Length of Lay, in. (Explanatory Note 3)	Annealed Tin or Lead-Alloy Coated	Annealed Silver Coated	50 to 100 µin. of Nickel[E]	Class 10 Nickel	Class 27 Nickel
0000–2109	2109[F]	0.0100	210 900	0.635	...	0.0576	0.0537	0.0559(2)	0.0610	0.0756
000–1672	1672[F]	0.0100	167 200	0.545	...	0.0727	0.0677	0.0705(2)	0.0770	0.0954
00–1330	1330[F]	0.0100	133 000	0.486	...	0.0914	0.0851	0.0887(2)	0.0967	0.120
0–1064	1064[F]	0.0100	106 400	0.435	...	0.114	0.106	0.111(2)	0.121	0.150
0–1045	1045[F]	0.0100	104 500	0.431	...	0.116	0.108	0.113(2)	0.123	0.153
1–836	836[F]	0.0100	83 600	0.386	...	0.145	0.135	0.141(2)	0.154	0.191
1–817[E]	817[F]	0.0100	81 700[E]	0.382	...	0.149	0.139	0.144(2)	0.158	0.195
2–665	665[F]	0.0100	66 500	0.342	...	0.183	0.170	0.177(2)	0.194	0.240
4–133[E]	133[F]	0.0179	42 615[E]	0.274	...	0.280	0.263	0.274(2)	0.299	0.371
4–420	420[G]	0.0100	42 000	0.275	...	0.289	0.270	0.281(2)	0.306	0.380
6–133[E]	133[F]	0.0142	26 818[E]	0.217	...	0.444	0.418	0.436(2)	0.475	0.589
6–266	266[G]	0.0100	26 600	0.220	...	0.457	0.426	0.443(2)	0.484	0.600
8–133[E]	133[F]	0.0113	16 983[E]	0.173	...	0.701	0.661	0.688(2)	0.751	0.930
8–168	168[G]	0.0100	16 800	0.177	...	0.724	0.674	0.702(2)	0.766	0.949
10–105	105[G]	1.0100	10 500	0.130	1.2 to 1.8	1.15	1.07	1.11(2)	1.21	1.50
10–104	104[H]	0.0100	10 400	0.130	1.7 to 2.1	1.16	1.08	1.12(2)	1.23	1.52
10–49[E]	49[G]	0.0142	9 880[G]	0.132	...	1.21	1.14	1.18(2)	1.29	1.60
10–37[E]	37[E]	0.0159	9 354[E]	0.115	1.10 to 1.75	1.26	1.19	1.24(2)	1.35	1.67
12–65	65[H]	0.0100	6 500	0.099	1.3 to 1.7	1.85	1.73	1.80(2)	1.96	2.43

Type II (Stranded Conductors)

Size Designation[B]	Conductor Construction					D-C Resistance at 20°C, Ω/1000 ft, max (Explanatory Note 2)				
	Number of Wires[C]	Nominal Diameter of Each Wire, in.	Calculated Cross-Sectional Area, cmils	Maximum Allowable Diameter, in.[D]	Length of Lay, in. (Explanatory Note 2)	Annealed Tin or Lead-Alloy Coated	Annealed Silver Coated	50 to 100 µin. of Nickel[I]	Class 10 Nickel	Class 27 Nickel
12–37[E]	37[E]	0.0126	5 874[E]	0.091	0.90 to 1.45	2.01	1.89	1.97(2)	2.15	2.66
12–19[E]	19[J]	0.0179	6 088[E]	0.093	0.90 to 1.45	1.92	1.81	1.88(2)	2.05	2.55
14–41	41[H]	0.0100	4 100	0.081	0.80 to 1.35	2.94	2.74	2.85(2)	3.11	3.85
14–19[E]	19[J]	0.0142	3 831[E]	0.073	0.80 to 1.15	3.05	2.87	2.99(2)	3.26	4.05
16–26	26[H]	0.0100	2 600	0.062	0.60 to 0.90	4.59	4.27	4.45(2)	4.86	6.02
16–19[E]	19[J]	0.0113	2 426[E]	0.059	0.60 to 0.90	4.82	4.54	4.73(2)	5.15	6.39
18–26[E]	26[H]	0.0080	1 664[E]	0.050	0.50 to 0.70	7.20	6.71	7.14(4)	7.63	9.45
18–19[E]	19[J]	0.0100	1 900[E]	0.052	0.50 to 0.70	6.22	5.79	6.03(2)	6.58	8.16

TABLE 1 *Continued*

Type II (Stranded Conductors)										
Conductor Construction						D-C Resistance at 20°C, Ω/1000 ft, max (Explanatory Note 2)				
Size Designation[B]	Number of Wires[C]	Nominal Diameter of Each Wire, in.	Calculated Cross-Sectional Area, cmils	Maximum Allowable Diameter, in.[D]	Length of Lay, in. (Explanatory Note 2)	Annealed Tin or Lead-Alloy Coated	Annealed Silver Coated	50 to 100 µin. of Nickel[I]	Class 10 Nickel	Class 27 Nickel
18–7[E]	7[J]	0.0159	1 770[E]	0.050	0.50 to 0.70	6.54	6.16	6.42(2)	7.00	8.67
~~20–19[E]~~	~~10[J]~~	~~0.0080~~	~~1 216[E]~~	~~0.042~~	~~0.45 to 0.55~~	~~9.76~~	~~9.10~~	~~9.68(4)~~	~~10.3~~	~~12.8~~
20–19[E]	19[J]	0.0080	1 216[E]	0.042	0.45 to 0.55	9.76	9.10	9.68(4)	10.3	12.8
~~20–19†~~	~~10[H]~~	~~0.0100~~	~~1 000~~	~~0.040~~	~~0.45 to 0.55~~	~~11.8~~	~~11.0~~	~~11.5(2)~~	~~12.5~~	~~15.5~~
20–10[E]	10[H]	0.0100	1 000	0.040	0.45 to 0.55	11.8	11.0	11.5(2)	12.5	15.5
20–7[E]	7[J]	0.0126	1 111[E]	0.039	0.45 to 0.55	10.4	9.81	10.2(2)	11.1	13.8
22–19[E]	19[J]	0.0063	754[E]	0.033	0.25 to 0.43	15.9	14.8	15.7(4)	16.8	20.8
22–7[E]	7[J]	0.0100	700[E]	0.031	0.25 to 0.43	16.7	15.6	16.2(2)	17.7	21.9
24–19[E]	19[J]	0.0050	475[E]	0.027	0.25 to 0.35	25.4	23.6	25.2(4)	26.9	33.3
24–7[E]	7[J]	0.0080	448[E]	0.025	0.25 to 0.35	26.2	24.5	26.0(4)	27.8	34.4
26–19[E]	19[J]	0.0040	304[E]	0.022	0.25 to 0.30	40.1	37.3	41.0(7)	42.4	52.6
26–7[E]	7[J]	0.0063	278[E]	0.020	0.25 to 0.30	42.6	39.7	42.2(4)	45.1	55.9
28–19[E]	19[J]	0.0031	183[E]	0.017	0.25 to 0.30	67.7	63.1	69.3(7)	71.7	88.8
28–7[E]	7[J]	0.0050	175[E]	0.016	0.25 to 0.30	68.2	63.6	67.6(4)	72.2	89.5
30–7[E]	7[J]	0.0040	112[E]	0.013	0.25 to 0.30	108.0	100.0	110.0(7)	114.0	141.0
~~32–7[E]~~	~~7[J]~~	~~0.0031~~	~~67[G]~~	~~0.011~~	~~0.10 to 0.30~~	~~182.0~~	~~170.0~~	~~186.0(7)~~	~~193.0~~	~~239.0~~
32–7[E]	7[J]	0.0031	67[G]	0.011	0.10 to 0.30	182.0	170.0	186.0(7)	193.0	239.0

[A] Provides minimum of 50 µin. of nickel.
[B] These size designations are solely for purposes of identification. They should not be confused with AWG sizes.
[C] The stranded conductor constructions shown in this table provide for finished noninsulated conductors having the indicated cross-sectional area. The number of component wires may vary slightly provided the specified resistances are not exceeded.
[D] The maximum allowable diameters of these conductors are given here for guidance in making calculations regarded insulating material, etc. These diameters do not include allowance for distortion of the conductor during stranding and are not intended to be used as limiting values.
[E] The cross-sectional areas of these conductor-size designations deviate by more than 2 per cent from the nominal areas of the standard AWG sizes as defined in Specification B258.
[F] Nineteen member ropes.
[G] Seven member ropes.
[H] Bunch-stranded.
[I] The numbers in parentheses indicate the class of nickel coating required to meet resistance values tabulated. These classes appear in Specification B355.
[J] Concentric-stranded.
~~†Editorially corrected.~~

3.1.2 Conductor size, designation, construction, and type (Table 1).

3.1.3 Whether tin, lead alloy, silver-coated, or nickel-coated (see 4.1).

3.1.4 For silver-coated conductors and nickel-coated conductors, class of coating (see 4.1), and when required, unannealed (see 4.2),

3.1.5 Desired constructions where alternates are given (Table 1, Type II and, 5.1, 6.1, and 6.2),

3.1.6 Package size (Section 12).

3.1.7 Special package marking if required (Section 11), and

3.1.8 Place of inspection (Section 10).

4. General Requirements

4.1 *Coating of Wires*—The coating of the solid conductors and the wires composing stranded conductors (before stranding) shall conform to the coating requirements of ASTM Specifications B33, B189, B298, and B355, as indicated on the purchase order.

4.2 *Temper*—Unless otherwise specified, all coated conductors shall be furnished in the annealed temper. When so specified, silver-coated conductors or nickel-coated conductors shall be furnished unannealed (Explanatory Note 1).

NOTE 1—The term unannealed as used in this specification means cold-worked conductor as produced on commercial wire-drawing machines.

4.3 *Elongation*—The elongation of annealed Type I conductors shall be as specified in Specifications B33, B189, B298, and B355 as applicable. The elongation of stranded conductors shall be permitted to vary from the requirements of the applicable Specifications: B33, B189, B298, and B355 by the following amounts:

4.3.1 For stranded conductors 22 AWG and smaller, the test shall be performed on the whole conductor and the elongation measured when the first strand of the conductor breaks. The minimum average elongation shall not be less than 10 % with no individual specimen less than 5 %.

4.3.2 For stranded conductors larger than 22 AWG, strands shall be carefully removed from the conductor and tested for elongation. The minimum average elongation shall not be less than 10 % with no individual strand less than 5 %.

4.4 *D-C Resistance*—The d-c resistance in ohms per 1000 ft of annealed solid and stranded conductor shall not exceed, before insulating, the appropriate values prescribed in Table 1 (Explanatory Note 2).

5. Conductor Construction

5.1 Solid conductors shall conform to the requirements for Type I conductors prescribed in Table 1.

5.2 Stranded conductors shall conform to the requirements for Type II conductors prescribed in Table 1. The method of stranding for conductor size designations 32-7 through 10-104 inclusive shall be at the option of the manufacturer unless otherwise specified. Stranded conductors size designation 10-105 and larger shall normally be furnished in a rope-lay-stranded construction consisting of either 7 or 19 bunch-stranded members.

6. Lay of Stranded Conductors

6.1 The direction of lay of the outside layer of stranded conductors shall be left-hand. The direction of lay of the bunch-stranded members composing rope-lay-stranded conductors shall be at the option of the manufacturer unless otherwise specified.

6.2 The direction of lay of the outer layer of rope-lay-stranded conductors shall be lefthand. The direction of lay of the other layers shall be reversed in successive layers, unless otherwise specified.