

Designation: B173 - 10 (Reapproved 2015)

Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors¹

This standard is issued under the fixed designation B173; 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 bare rope-lay-stranded conductors having concentric-stranded members made from round copper wires, either uncoated or coated with tin, lead, or lead-alloy for use as electrical conductors (Explanatory Note 1 and Note 2).

1.2 Coated wires shall include only those wires with finished diameters and densities substantially equal to the respective diameters and densities of uncoated wires.

1.3 The values stated in inch-pound or SI units are to be regarded separately as standard. Each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. For conductor sizes designated by AWG or kcmil, the requirements in SI units have been numerically converted from corresponding values, stated or derived, in inch-pound units. For conductor sizes designated by SI units only, the requirements are stated or derived in SI units.

1.3.1 For density, resistivity, and temperature, the values stated in SI units are to be regarded as standard.

2. Referenced Documents

2.1 The following documents of the issue in effect at the time of reference form a part of this specification to the extent referenced herein:

2.2 ASTM Standards:²

B3 Specification for Soft or Annealed Copper Wire

B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B33 Specification for Tin-Coated Soft or Annealed Copper

Wire for Electrical Purposes

- B172 Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors
- **B189** Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
- B193 Test Method for Resistivity of Electrical Conductor Materials
- B263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors
- B354 Terminology Relating to Uninsulated Metallic Electrical Conductors
- 2.3 American National Standard:
- ANSI C42.35 Definitions of Electrical Terms³

3. Classification

3.1 For the purpose of this specification rope-lay-stranded conductors having concentric-stranded members are classified as follows:

3.1.1 Class G—Conductors consisting of 7 to 61 rope-laystranded members, each of which consists of 7 to 19 concentric-stranded wires, with total conductor sizes ranging from No. 14 AWG (2.08 mm²) to 5 000 000 cmil (2534 mm²). (Typical use is for rubber-sheathed conductor, apparatus conductor, portable conductor, and similar applications.)

3.1.2 *Class H*—Conductors consisting of 19 to 91 rope-laystranded members, each of which consists of 7 to 19 concentric-stranded wires, with total conductor sizes ranging from No. 9 AWG (6.63 mm^2) to 5 000 000 cmil (2534 mm^2). Class K construction produces a conductor with greater flexibility than class G. (Typical use is for rubber-sheathed cord and applications where flexibility is required such as on take-up reels over sheaves and extra-flexible apparatus conductor.)

4. Ordering Information

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

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

4.1.1 Quantity of each size and class;

4.1.2 Conductor size: circular-mil area or AWG (Section 7);

4.1.3 Class (Section 3 and Tables 1 and 2);

4.1.4 Whether coated or uncoated; if coated, designate type of coating (see 11.1);

4.1.5 Details of special-purpose lays, if required (see 6.2 and 6.3) and (Explanatory Note 3);

4.1.6 Package size (see 14.1);

- 4.1.7 Special package marking, if required (Section 15);
- 4.1.8 Lagging, if required (see 14.2); and
- 4.1.9 Place of inspection (Section 13).

5. Joints

5.1 Necessary joints in wires or in groups of wires shall be made in accordance with accepted commercial practice, taking into account the size of the wire or group of wires as related to the size of the entire conductor.

5.2 Concentric-stranded members forming the completed conductor may be joined as a unit by soldering, brazing, or welding.

5.3 Joints shall be so constructed and so disposed throughout the conductor that the diameter or configuration of the completed conductor is not substantially affected, and so that the flexibility of the completed conductor is not adversely affected.

6. Lay (Explanatory Note 3)

6.1 Conductors of the same size and description furnished on one order shall have the same lay.

6.2 The length of lay of the outer layer of the rope-lay stranded conductor shall be not less than 8 nor more than 16 times the outside diameter of the completed conductor. The length of lay of the other layers shall be at the option of the manufacturer unless specifically agreed upon. The direction of lay of the outer layer shall be left-hand, unless the direction of lay is specified otherwise by the purchaser. The direction of lay of the other layers shall be reversed in successive layers, unless otherwise agreed upon between the manufacturer and the purchaser.

6.3 The length of lay of the individual wires composing the stranded members shall be not less than 8 nor more than 16 times the outside diameter of that layer. Unless otherwise specified, the direction of lay of the outer layer of wires shall be at the option of the manufacturer. The direction of lay shall be reversed in successive layers, unless otherwise agreed upon between the manufacturer and the purchaser.

7. Construction

7.1 The area of cross section and the number and diameter of wires for a variety of strand constructions in general use are shown in Tables 1 and 2.

8. Physical and Electrical Tests

8.1 Tests for the electrical properties of wires composing conductors made from soft or annealed copper wire, bare or coated, shall be made before stranding.

8.2 Tests for the physical properties of soft or annealed copper wire, bare or coated, may be made upon the wires before stranding or upon wires removed from the completed stranded conductors, but need not be made upon both. Care shall be taken to avoid mechanical injury and stretching when removing wires from the conductor for the purpose of testing.

8.3 The physical properties of wire when tested before stranding shall conform to the applicable requirements of 11.1.

8.4 The physical properties of wires removed from the completed stranded conductor shall be permitted to vary from the applicable requirements of 11.1 by the following amounts: (Explanatory Note 4):

8.4.1 Average of Results Obtained on All Wires Tested—The percent minimum elongation may be reduced by the value of 5 % from the values required for unstranded wires as specified by Specifications B3, B33, or B189, as applicable. For example, where the unstranded wire specification requires minimum elongation of 30 %, wire of that material removed from Specification B173 stranded conductor shall meet a minimum elongation value of 25 %, a value 5 % reduction.

8.4.2 *Results Obtained on Individual Wires*—The percent minimum elongation may be reduced by the value of 15 % from the values required for unstranded wires as specified by Specifications B3, B33, or B189, as applicable. For example, where the unstranded wire specification requires minimum elongation of 30 % wire of that material removed from Specification B173 stranded conductor shall meet a minimum elongation value of 15 %. If the reduction results in minimum elongation of less than 5 %, a minimum of 5 % shall apply.

8.5 In the event that the requirements prescribed in 8.4.2 are met, but those prescribed in 8.4.1 are not met, a retest shall be permitted wherein all wires of a conductor of 100 wires or less, or 100 wires selected at random throughout a conductor of more than 100 wires shall be tested for the purpose of final determination for conformance to 8.4.

8.6 Elongation tests to determine compliance shall not be made on the conductor as a unit.

8.7 If a tinning, lead-coating, or lead-alloy-coating test is required, it shall be made on the wires prior to stranding.

9. Density

9.1 For the purpose of calculating mass, cross sections, etc., the density of copper shall be taken as 8.89 g/cm³ (0.32117 lb/in.³) at 20°C (Explanatory Note 5).

10. Mass and Resistance

10.1 The mass and electrical resistance of a unit length of stranded conductor are a function of the length of lay. The approximate mass and electrical resistance may be determined using the standard increments shown in Explanatory Note 6. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 7).

10.2 The maximum electrical resistance of a unit of stranded conductor shall not exceed 2 % over the nominal DC resistance shown in Table 1 and Table 2. When the DC

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228 259 0.0417 1.06 7 0.876 203 1.77 259 0.0393 1.00 7 0.876 177 259 0.0393 1.00 7 0.876 177 259 0.0393 1.00 7 0.875 177 259 0.0340 0.86 7 0.73 177 259 0.0340 0.86 7 0.773 107 0000 133 0.0311 0.79 7 0.73 107 0000 133 0.03156 0.90 7 0.743 9 85.5 0 1.33 0.03156 0.80 7 0.653 1.01 7 0.0133 0.0282 0.72 7 0.474 1 1.43 853.5 0 0.133 0.0282 0.72 7 0.643 1.43 10.5 7 0.133 0.0282 0.74 7 0.341 11.6 7 0.133 0.0282 0.74 7 0.263 <td< td=""><td>500 000</td><td>253</td><td>: :</td><td>259</td><td>0.0439</td><td>1.12</td><td>. ~</td><td>0.922</td><td>23.4</td><td>1579</td><td>2350</td><td>0.0217</td><td>0.0711</td><td>0.0221</td><td>0.0725</td><td>0.0225</td><td>0.0740</td><td>0.0230</td><td>0.0755</td></td<>	500 000	253	: :	259	0.0439	1.12	. ~	0.922	23.4	1579	2350	0.0217	0.0711	0.0221	0.0725	0.0225	0.0740	0.0230	0.0755
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	450 000	228	:	259	0.0417	1.06	7	0.876	22.3	1425	2120	0.0241	0.0790	0.0246	0.0806	0.0251	0.0822	0.0255	0.0838
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	400 000	203	:	259	0.0393	1.00	7	0.825	21.0	1265	1883	0.0271	0.0889	0.0276	0.0907	0.0282	0.0924	0.0288	0.0942
102 259 0.0340 0.08 0.0311 0.7 0.01 107 0000 133 0.0311 0.79 7 0.653 107 0000 133 0.0316 0.90 7 0.653 85.5 0 001 133 0.0316 0.90 7 0.653 87.4 00 133 0.0316 0.80 7 0.653 1.01 7 0.533 85.5 0 133 0.03282 0.72 7 0.533 1.01 7 0.533 33.6 2 49 0.03282 0.72 7 0.423 1.43 0.263 1.44 1.33 0.265 1.44 0.331 1.44 0.265 1.44 1.43 0.265 1.44 1.45 1.44 0.266 1.44 <	350 000	1/1	:	259	0.0368	0.93	∼ 1	0.773	19.6	1109	1651	0.0310	0.102	0.0316	0.104	0.0322	0.106	0.0328	0.108
107 000 133 0.0399 1.01 0.03 107 000 133 0.0396 1.01 7 0.65 88.0 00 133 0.0316 0.80 7 0.65 87.4 00 133 0.03285 0.90 7 0.559 87.0 00 133 0.0282 0.72 7 0.474 7 0 133 0.0282 0.72 7 0.474 7 0 133 0.0282 0.72 7 0.423 33.6 2 49 0.0286 0.83 7 0.317 26.1 4 0.0282 0.72 7 0.423 21.1 4 49 0.0280 0.83 7 0.263 10.5 7 4 0.0260 0.65 7 0.264 110.5 7 0.184 0.147 7 0.186 8.37 8 3.64 0.0184 0.647 7 0.166 8.37 8 9 0.018	300 000	201	:	2020	0.0340	0.00		0.652	- 9 9 4	702	1170	1050.0	0.119	0.0442	0.121	0.03/0	0.123	0.0364	0.120
85.0 000 133 0.0355 0.90 7 0.533 67.4 000 133 0.0282 0.72 7 0.474 53.5 0 133 0.0282 0.72 7 0.474 33.6 2 49 0.0282 0.72 7 0.474 26.7 3 0.0286 0.93 7 0.474 33.6 2 49 0.0328 0.93 7 0.474 26.7 3 49 0.0328 0.83 7 0.317 21.1 4 49 0.0292 0.74 7 0.295 21.1 5 49 0.0266 0.74 7 0.295 10.5 7 0.183 0.59 7 0.205 8.37 8 3 0.0184 0.47 7 0.185 8.37 8 9 0.0184 0.616 0.148 0.148 9 9 0.0184 0.0184 0.148 0.148	211 600	101		133	0.0399	101	- ۲	0.599	64	667	600	0.6510	0.167	06500	0.170	0.630.0	0.174	0.0541	0.177
67.4 00 133 0.0316 0.80 7 0.474 53.5 0 133 0.0282 0.72 7 0.474 42.4 1 133 0.0282 0.72 7 0.474 33.6 2 49 0.0368 0.93 7 0.317 26.7 3 49 0.0328 0.93 7 0.317 21.1 4 49 0.0328 0.83 7 0.317 21.1 5 49 0.0290 0.66 7 0.295 21.1 6.63 6 7 0.203 0.61 7 0.205 21.1 6 49 0.0260 0.66 7 0.203 10.63 8.37 8 3 6 0.0184 0.47 7 0.185 8.37 8 9 0.0184 0.0163 0.0148 0.166 8.37 8 7 0.185 0.149 0.166 0.148	167 800	85.0	000	133	0.0355	0.90	. ~	0.533	13.5	528	785	0.0643	0.211	0.0656	0.215	0.0668	0.219	0.0681	0.223
53.5 0 133 0.0282 0.72 7 0.423 42.4 1 133 0.0251 0.64 7 0.311 26.7 33.6 2 49 0.0368 0.93 7 0.311 26.7 3 49 0.0328 0.83 7 0.311 21.1 4 49 0.0292 0.74 7 0.295 21.1 5 49 0.0260 0.74 7 0.295 21.1 6 49 0.0260 0.66 7 0.203 10.5 7 49 0.0214 0.55 7 0.203 8.37 8 3 0.6184 0.47 7 0.185 8.37 8 49 0.0184 0.41 7 0.166	133 100	67.4	8	133	0.0316	0.80	7	0.474	12.0	418	622	0.0810	0.266	0.0826	0.271	0.0843	0.276	0.0860	0.282
42.4 1 133 0.0251 0.64 7 0.377 33.6 2 49 0.0368 0.93 7 0.331 26.7 3 49 0.0328 0.83 7 0.331 21.1 4 9 0.0328 0.83 7 0.295 21.1 5 49 0.0292 0.74 7 0.293 16.8 5 7 0.0260 0.66 7 0.293 13.3 6 49 0.0260 0.66 7 0.293 13.3 6 49 0.02106 0.52 7 0.185 8.37 8 39 9 0.0163 0.41 7 0.166 6.65 9 0.0163 0.41 7 0.166 0.166	105 600	53.5	0	133	0.0282	0.72	7	0.423	10.7	333	495	0.102	0.335	0.104	0.342	0.106	0.348	0.108	0.355
33.6 2 49 0.0368 0.93 7 0.331 26.7 3 49 0.0328 0.93 7 0.295 21.1 4 49 0.0292 0.74 7 0.263 16.8 5 49 0.0260 0.66 7 0.293 13.3 6 49 0.0201 0.66 7 0.293 13.3 7 49 0.0206 0.66 7 0.283 10.5 7 49 0.0206 0.52 7 0.185 8.37 8 49 0.0163 0.41 7 0.165 6.63 9 49 0.0163 0.41 7 0.168	83 690	42.4	-	133	0.0251	0.64	7	0.377	9.6 -b	264	393	0.129	0.423	0.132	0.431	0.134	0.440	0.137	0.449
26.7 3 49 0.0328 0.83 7 0.295 21.1 4 49 0.0292 0.74 7 0.263 16.8 5 49 0.0260 0.66 7 0.234 13.5 7 49 0.0206 0.66 7 0.234 13.5 7 49 0.0206 0.66 7 0.234 13.5 7 49 0.0206 0.52 7 0.185 8.37 8 49 0.0163 0.47 7 0.166 6.63 9 49 0.0163 0.41 7 0.166	66 360	33.6	2	49	0.0368	0.93	7	0.331	8.4 17	207	308	0.161	0.528	0.164	0.539	0.167	0.549	0.170	0.560
21.1 4 49 0.0292 0.74 7 0.263 16.8 5 49 0.0260 0.66 7 0.234 13.3 6 49 0.0231 0.59 7 0.234 10.5 7 49 0.0206 0.52 7 0.186 8.37 8 49 0.0163 0.47 7 0.166 6.63 9 49 0.0163 0.41 7 0.148	52 620	26.7		49	0.0328	0.83	~ 1	0.295	2. 13.	164	245	0.203	0.666	0.207	0.679	112.0	0.693	0.215	0.707
10.0 5 49 0.0231 0.59 7 0.208 113.3 6 49 0.0231 0.59 7 0.208 10.5 7 49 0.0206 0.55 7 0.168 8.37 8 49 0.0163 0.47 7 0.168 6.63 9 49 0.0163 0.41 7 0.148 6.63 9 49 0.0163 0.41 7 0.148	4 1 / 40	1.12	4 u	64	0.0262	0.74	- 1	502.0	- 0 -	130	194	002.0	0.840	1 92.0	1.65.0	007.0	0.8/3	1/2.0	0.890
10.5 7 49 0.0206 0.52 7 0.185 0.185 0.168	25 UBU 26 240	0.01	ი დ	40	0.0231	0.00		0.208	ດ ດີ () 2	81.5 8	124	0.407	1.34	0.415	1.37	0.000	1.30	0.431	1 42
8.37 8 49 0.0184 0.47 7 0.166 5 6.63 9 49 0.0163 0.41 7 0.148	20 820	10.5		49	0.0206	0.52		0.185	00 7 4 7 0	64.8	96.5	0.513	168	0.523	1 71	0.534	1 75	0.545	1 79
6.63 9 49 0.0163 0.41 7 0.148	16510	8.37	- 00	49	0.0184	0.47	. ~	0.166	45 15	51.7	77.0	0.647	2.12	0.660	2.16	0.687	2.25	0.701	2.30
	13 090	6.63	ი	49	0.0163	0.41	7	0.148	3.8	40.6	60.4	0.816	2.68	0.832	2.73	0.867	2.84	0.884	2.90
5.26 10 49 0.0146 0.37 7 0.131	10 380	5.26	10	49	0.0146	0.37	7	0.131	3.3	32.6	48.5	1.03	3.38	1.05	3.45	1.09	3.59	1.11	3.66

TABLE 1 Constructional and DC Resistance Requirements of Rope-Lay Stranded Copper Conductors Having Concentric-Stranded Members-Class G^A

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