Designation: B 496 – 01

Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors[1]

This standard is issued under the fixed designation B 496; 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.

1. Scope

1.1 This specification covers bare compact round concentric-lay-stranded conductors made from uncoated round copper wires for general use for electrical purposes. These conductors shall be constructed with a central core surrounded by one or more layers of helically laid compacted wires (Explanatory Note 1 and Note 2).

1.2 The values stated in inch-pound or SI units are to be regarded separately as standard. The values in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.2.1 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 on date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*

B 3 Specification for Soft or Annealed Copper Wire[2]

B 263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors[2]

B 354 Terminology Relating to Uninsulated Metallic Electrical Conductors[2]

3. Ordering Information

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

3.1.1 Quantity of each size (Table 1),

3.1.2 Conductor size; circular-mil area or AWG, (Section 6 and Table 1),

3.1.3 Packaging (Section 14), if required,

3.1.4 Special package marking, and

3.1.5 Place of inspection (Section 16).

4. Joints

4.1 Welds and brazes may be made in rods or in wires prior to final drawing.

4.2 Welds and brazes may be made in the individual round drawn wires for compact conductors, but shall not be closer together than 1 ft (300 mm) for conductor of 19 wires or less or closer than 1 ft (300 mm) in a layer for conductor of more than 19 wires.

4.3 No joint nor splice shall be made in a compact-stranded conductor as a whole.

5. Lay

5.1 The length of lay shall be not less than 8 nor more than 16 times the outside diameter of the completed conductor.

5.2 The direction of lay of the outer layer shall be left-hand, and it may be reversed or unidirectional in successive layers.

6. Construction

6.1 The construction of the compact round concentric-lay-stranded conductors shall be as shown in Table 1.

6.2 The starting round copper wires used in the fabrication of the compact round conductor shall be of such diameter as to produce a finished conductor having a nominal cross-sectional area and diameter as prescribed in Table 1.

7. Density

7.1 For the purpose of calculating linear densities, cross sections, etc., the density of the copper shall be taken as 8.89 g/cm ^{3}(0.32117 lb/in.^{3}) at 20°C.

8. Mass and Resistance

8.1 The mass per unit length and d-c electrical resistance of a compact round conductor are greater than the total of these characteristics of the compressed wires composing the finished conductor, depending upon the lay. The standard increment of mass per unit length and electrical resistance shall be taken as 2 %. The nominal mass per unit length and d-c resistance are shown in Table 1. When the d-c resistance is measured at other than 20°C, it shall be corrected by using the multiplying factors given in Table 2.

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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 B01.04 on Conductors of Copper and Copper Alloys.

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

TABLE 1 Construction Requirements of Compact Round Concentric-Lay-Stranded Copper Conductors

Conductor Size			Number of Wires	Compact Conductor Diameter		Mass, lb/1000 ft	Mass, kg/km	D–C Resistance at 20°C	
cmil	AWG	mm^2		in.	mm			Ω/1000 ft	Ω/km
1 000 000	...	507	61[A]	1.060	26.9	3086	4590	0.0106	0.0347
900 000	...	456	61[A]	0.999	25.4	2780	4140	0.0118	0.0386
800 000	...	405	61[A]	0.938	23.8	2469	3680	0.0132	0.0433
750 000	...	380	61[A]	0.908	23.0	2316	3450	0.0141	0.0462
700 000	...	355	61[A]	0.877	22.3	2160	3220	0.0151	0.0495
650 000	...	329	61[A]	0.845	21.4	2006	2990	0.0163	0.0535
600 000	...	304	61[A]	0.813	20.6	1850	2760	0.0176	0.0577
550 000	...	279	61[A]	0.775	19.7	1700	2530	0.0192	0.0630
500 000	...	253	37[B]	0.736	18.7	1542	2300	0.0212	0.0695
450 000	...	228	37[B]	0.700	17.8	1390	2070	0.0235	0.0770
400 000	...	203	37[B]	0.659	16.7	1236	1840	0.0264	0.0865
350 000	...	177	37[B]	0.616	15.7	1080	1610	0.0302	0.0990
300 000	...	152	37[B]	0.570	14.5	925	1380	0.0353	0.116
250 000	...	127	37[B]	0.520	13.2	772	1150	0.0423	0.139
211 600	4/0	107	19[C]	0.475	12.1	653	972	0.0500	0.164
167 800	3/0	85.0	19[C]	0.423	10.8	518	771	0.0630	0.206
133 100	2/0	67.4	19[C]	0.376	9.57	411	611	0.0795	0.261
105 600	1/0	53.5	19[C]	0.336	8.55	326	485	0.100	0.328
83 690	1	42.4	19[C]	0.299	7.60	259	385	0.126	0.413
66 360	2	33.6	7	0.268	6.81	205	305	0.159	0.521
41 740	4	21.2	7	0.213	5.41	129	192	0.253	0.830
26 240	6	13.3	7	0.169	4.29	80.9	121	0.403	1.32
16 510	8	8.37	7	0.134	3.40	51.0	75.9	0.641	2.10

[A] 58 wires minimum.
[B] 35 wires minimum.
[C] 18 wires minimum.

TABLE 2 Temperature Correction Factors for Conductor Resistance

Temperature, °C	Multiplying Factor for Reduction to 20°C
0	1.085
5	1.063
10	1.041
15	1.020
20	1.000
25	0.981
30	0.962
35	0.944
40	0.927
45	0.911
50	0.895
55	0.879
60	0.864
65	0.850
70	0.836
75	0.822
80	0.809
85	0.797
90	0.784

8.2 In cases where the lay is definitely known, the increment may be calculated if desired (Explanatory Note 3).

8.3 For conductors to be used in covered or insulated wires or cables, direct current (D-C) resistance measurement may be used instead of the method outlined in Section 9, to determine compliance with this specification.

9. Variation in Area

9.1 The cross-sectional area of the compact round conductor shall be not less than 98 % of the cross-sectional area as specified in Column 1 of Table 1.

9.2 The manufacturer shall determine the cross-sectional area by Test Method B 263. In applying this method, the increment in mass per unit length resulting from stranding may be the applicable value specified in 9.1 or may be calculated from the measured dimensions of the sample under test. In case of question regarding area compliance, the actual mass per unit length increment due to stranding shall be calculated.

10. Variation in Diameter

10.1 The average diameter of the compact-round conductor shall not vary by more than plus 1 % and minus 2 % from the diameter specified in Table 1.

11. Finish

11.1 The conductor surface shall be smooth and free of imperfections not consistent with the best commercial practice.

12. Physical and Electrical Tests

12.1 Tests for the physical and electrical properties of wires composing the conductors shall be made before stranding in accordance with Specification B 3 (Explanatory Note 4 and Note 5).

13. Requirements for Wires

13.1 Before stranding and compacting the copper wire shall meet all of the requirements of Specification B 3.

13.2 Wire shaped before stranding shall meet the requirements of Specification B 3, except for diameter tolerance. The elongation requirement shall be the same as round wires of equal nominal area. The area tolerance for shaped wires shall be such that the finished conductor conforms to Section 10 of this specification.

14. Inspection

14.1 All tests and inspection shall be made at the place of manufacture unless otherwise especially agreed upon between the manufacturer and the purchaser at the time of purchase. The

manufacturer shall afford the inspector representing the purchaser all reasonable facilities, without charge, to satisfy him that the material is being furnished in accordance with this specification.

15. Packaging and Package Marking

15.1 Package sizes for conductors shall be agreed upon by the manufacturer and the purchaser in the placing of individual orders.

15.2 The conductors shall be protected against damage in ordinary handling and shipping.

15.3 The net mass, length, size, kind of conductor, purchase order number, and any other marks required by the purchase order shall be marked on a tag attached to the end of the conductor inside of the package. The same information, together with the manufacturer's serial number (if any) and all shipping marks required by the purchaser, shall appear on the outside of each package.

16. Keywords

16.1 compact copper conductor; compact round concentric-lay-stranded copper conductor; concentric-lay-stranded copper conductor; copper electrical conductor; electrical conductor; electrical conductor—copper; stranded copper conductor

EXPLANATORY NOTES

NOTE 1—In this specification only compact round concentric-lay-stranded conductor constructions are specifically designated. Constructions not included in this specification should be specifically agreed upon between the manufacturer and the purchaser when placing the order.

NOTE 2—For definitions of terms relating to conductors, reference should be made to Terminology B 354.

NOTE 3—The increment of mass or electrical resistance of a completed concentric-lay-stranded conductor, *k*, in % is:

$$k = 100(m - 1)$$

where *m* is the stranding factor, and is the ratio of the mass or electrical resistance of a unit length of stranded conductor to that of a solid conductor of the same cross-sectional area or of a stranded conductor with infinite length of lay, that is, all wires parallel to the conductor axis. The stranding factor *m* for the completed stranded conductor is the numerical average of the stranding factors for each of the individual wires in the conductor, including the straight core wire, if any (for which the stranding factor is unity). The stranding factor, m_{ind}, for any given wire in a concentric-lay-stranded conductor is:

$$m_{ind} = \sqrt{1 + (9.8696/n^2)}$$

where n = (length of lay)/diameter of helical path of the wire.

The derivation of the above as given in *NBS Handbook 100*[3] is based on round wire constructions which are applicable to compacted wire constructions.

NOTE 4—Individual wires are not to be unlaid from compact round conductors for testing purposes. The physical properties of the individual compacted wires will be altered by the deformation brought about by compacting, unlaying, and straightening for test.

NOTE 5—To test stranded conductors for tensile strength successfully as a unit requires adequate means of gripping the ends of the test specimen without causing damage that may result in failure below the actual strength of the conductor. Various means are available, such as compression sleeves, split sleeves, and preformed grips, but ordinary jaws or clamping devices usually are not suitable.

[3] Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.