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Standard Specification for Compact Round Stranded Copper Conductors Using Single Input Wire Construction[1]

This standard is issued under the fixed designation B835; 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 stranded conductors made from uncoated copper wires of a single input wire (SIW) diameter for general use in covered or insulated electrical wires or cables. These conductors shall be constructed with one or more layers of helically laid compacted wires (Explanatory Note 1, Note 2, and Note 3).

1.2 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.

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

1.3 *This standard does not purport to address all of the safety concerns, 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.*

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]

B3 Specification for Soft or Annealed Copper Wire

B263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

2.3 *NIST Document:*[3]

NBS Handbook 100 Copper Wire Tables

3. Classification

3.1 The conductors described in this specification are intended for subsequent insulation or covering. The classification of these conductors is SIW compact.

4. Ordering Information

4.1 Orders for material in accordance with this specification shall include the following information:

4.1.1 Quantity of each size (Table 1);

4.1.2 Conductor size, circular-mil area, or AWG (Section 8);

4.1.3 Packaging (Section 16), if required;

4.1.4 Special package marking; and

4.1.5 Place of inspection (Section 15).

5. Requirements for Wires

5.1 Before stranding and compacting, the copper wire shall meet all of the requirements of Specification B3.

6. Joints

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

6.2 Welds and brazes may be made in the individual wires for compact conductors, but they shall not be closer together than 1 ft (0.3 m) for conductor of 19 wires or less or closer than 1 ft (0.3 m) in a layer for conductor of more than 19 wires.

6.3 No joint or splice shall be made in a compact-stranded conductor as a whole.

7. Lay

7.1 The length of lay shall not be less than 8 or more than 16 times the outside diameter of the completed conductor.

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

7.3 Other lay requirements may be furnished upon special agreement between the manufacturer and the purchaser.

8. Construction

8.1 The construction of the compact round SIW stranded conductors shall be as given in Table 1.

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

TABLE 1 Construction Requirements of Compact Round SIW-Stranded Copper Conductors

Conductor Size			Minimum Number of Wires	Compact Conductor Diameter		Mass/1000 ft, lb/1000 ft	Mass/km, kg/km	dc Resistance at 20°C	
Circular, mils	AWG	mm^2		in.	mm			Ω/1000 ft	Ω/km
1 000 000	...	507	53	1.060	26.9	3086	4590	0.0106	0.0347
900 000	...	456	53	0.999	25.4	2780	4140	0.0118	0.0386
800 000	...	405	53	0.938	23.8	2469	3680	0.0132	0.0433
750 000	...	380	53	0.908	23.0	2316	3450	0.0141	0.0462
700 000	...	355	34	0.877	22.3	2160	3220	0.0151	0.0495
650 000	...	329	34	0.845	21.4	2006	2990	0.0163	0.0535
600 000	...	304	34	0.813	20.6	1850	2760	0.0176	0.0577
550 000	...	279	34	0.775	19.7	1700	2530	0.0192	0.0630
500 000	...	253	30	0.736	18.7	1542	2300	0.0212	0.0695
450 000	...	228	30	0.700	17.8	1390	2070	0.0235	0.0770
400 000	...	203	24	0.659	16.7	1236	1840	0.0264	0.0865
350 000	...	177	24	0.616	15.7	1080	1610	0.0302	0.0990
300 000	...	152	18	0.570	14.5	925	1380	0.0353	0.116
250 000	...	127	18	0.520	13.2	772	1150	0.0423	0.139
211 600	4/0	107	17	0.475	12.1	653	972	0.0500	0.164
167 800	3/0	85.0	15	0.423	10.8	518	771	0.0630	0.206
133 100	2/0	67.4	12	0.376	9.57	411	611	0.0795	0.261
105 600	1/0	53.5	7	0.336	8.55	326	485	0.100	0.328
83 690	1	42.4	7	0.299	7.60	259	385	0.126	0.413
66 350	2	33.6	6	0.268	6.81	205	305	0.159	0.521
41 740	4	21.2	6	0.213	5.41	129	192	0.253	0.830
26 240	6	13.3	6	0.169	4.29	80.9	121	0.403	1.32
16 510	8	8.37	6	0.134	3.40	51.0	75.9	0.641	2.10

8.2 Wires used in the fabrication of the compact round conductor shall be of such dimensions as to produce a finished conductor as prescribed in Table 1.

9. Density

9.1 For the purpose of calculating mass per unit length, cross sections, and so forth, the density of the copper shall be taken as 8.89 g/cm^3 (0.32117 $lb/in.^3$) at 20°C.

10. Mass and Electrical Resistance

10.1 The mass and electrical resistance of a unit length of stranded unsealed conductor are a function of the length of lay. The approximate mass and electrical resistance may be determined using an increment of 2 %. When greater accuracy is desired, the increment based on the specific lay of the conductor may be calculated (Explanatory Note 4).

10.2 The maximum electrical resistance of a unit length of stranded conductor shall not exceed 102 % of the nominal dc resistance shown in Table 1. When the dc resistance is measured at other than 20°C, it is to be corrected by using the multiplying factor given in Table 2.

10.3 For conductors to be used in covered or insulated wires or cables, dc resistance measurement may be used instead of the method outlined in Section 11, to determine compliance with this specification.

11. Variation in Area

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

11.2 The manufacturer shall determine the cross-sectional area by Test Method B263. In applying this test method, the increment in mass per unit length resulting from stranding may be the applicable value specified in 10.1 or may be calculated from the measured dimensions of the sample under test. In case of a question regarding area compliance, the actual mass per unit length increment due to stranding shall be calculated.

TABLE 2 Temperature Correction Factors for Conductor Resistance

Temperature,°C	Multiplying Factor for Correction 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

12. Variation in Diameter

12.1 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.

13. Finish

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

14. Physical and Electrical Tests

14.1 Tests for the physical and electrical properties of wires composing the conductors shall be made before stranding in accordance with Specification B3 (Explanatory Note 5 and Note 6).

15. Inspection

15.1 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.

16. Packaging and Package Marking

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

16.2 The conductors shall be protected from damage during ordinary handling and shipping.

16.3 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.

17. Keywords

17.1 compact copper conductor; compact round SIW stranded copper conductor; copper electrical conductor; electrical conductor; electrical conductor—copper; SIW stranded copper conductor; stranded copper conductor

EXPLANATORY NOTES

NOTE 1—In this specification, only compact round single input wire 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 B354.

NOTE 3—*Single Input Wire Construction*—A stranded conductor design methodology that varies the number of wires within a range of conductor sizes in order to permit that range of conductor sizes to be constructed from a single wire size.

NOTE 4—The increment of weight or electrical resistance of a completed concentric-lay-stranded conductor (k), in %, is as follows:

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

where m = the stranding factor and is also the ratio of the weight of 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 as follows:

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

where:

$$n = \frac{\text{length of lay}}{\text{diameter of helical path of the wire}}$$

NOTE 5—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 6—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 are usually not suitable.