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Standard Specification for Concentric-Lay-Stranded Copper-Clad Steel Conductors[1]

This standard is issued under the fixed designation B228; 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 Department of Defense.

1. Scope

1.1 This specification covers bare concentric-lay-stranded conductors made from bare round copper-clad steel wires for general use for electrical purposes.

1.2 For the purpose of this specification, conductors are classified as follows: Grade 40 HS, Grade 30 HS, and Grade 30 EHS.

1.3 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 *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 the date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B227 Specification for Hard-Drawn Copper-Clad Steel Wire

B354 Terminology Relating to Uninsulated Metallic Electrical Conductors

2.3 *ANSI Standards:*

C42 Definitions of Electrical Terms[3]

2.4 *National Institute of Standards and Technology:*

NBS *Handbook 100—Copper Wire Tables*[4]

3. Ordering Information

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

3.1.1 Quantity of each size and grade;

3.1.2 Conductor size: approximate diameter in fractions of an inch, or number and AWG size of individual wires (Section 7 and Table 1);

3.1.3 Grade (see 1.2 and Table 1);

3.1.4 Direction of lay of outer layer, if other than left-hand (see 6.3);

3.1.5 When physical tests shall be made (see 8.2);

3.1.6 Package size (see 13.1);

3.1.7 Special package marking, if required (Section 12);

3.1.8 Lagging, if required (see 13.2); and

3.1.9 Place of inspection (Section 14).

3.2 In addition, Supplementary Requirements shall apply only when specified by the purchaser in the inquiry, contract, or purchase order for direct procurement by agencies of the U. S. Government (S1, S2, and S3).

4. Material for Wires

4.1 The purchaser shall specify the grade of wire to be used in the conductor.

4.2 Before stranding, the copper-clad steel wire shall meet all the requirements of Specification B227.

4.3 All wires in the conductor shall be of the same grade and quality.

5. Joints

5.1 Joints or splices may be made in the finished individual copper-clad steel wires composing concentric-lay-stranded conductors, using more than three wires provided that such joints or splices have a protection equivalent to that of the wire itself and that they do not decrease the strength of the finished

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

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TABLE 1 Construction Requirements and Breaking Strength of Concentric-Lay-Stranded Copper-Clad Steel Conductors

NOTE 1—*Metric Equivalents*—For diameter, 1 in. = 25.40 mm (round to four significant figures); for breaking strength, 1 lb = 0.45359 kg (round to four significant figures).

Size Designation		Conductor Diameter, in.[A]	Rated Breaking Strength, min, lb[B]		
Inch[C]	AWG[D]		Grade 40 HS	Grade 30 HS	Grade 30 EHS
7/8	19 No. 5	0.910	48 740	53 910	64 910
13/16	19 No. 6	0.810	40 370	44 470	53 880
23/32	19 No. 7	0.721	33 360	36 610	44 480
21/32	19 No. 8	0.642	27 550	30 140	36 590
9/16	19 No. 9	0.572	22 690	24 730	29 700
5/8	7 No. 4	0.613	21 630	24 040	28 540
9/16	7 No. 5	0.546	17 960	19 860	23 910
1/2	7 No. 6	0.486	14 870	16 390	19 850
7/16	7 No. 7	0.433	12 290	13 490	16 390
3/8	7 No. 8	0.385	10 150	11 100	13 480
11/32	7 No. 9	0.343	8359	9113	10 940
5/16	7 No. 10	0.306	6913	7531	8928
. . .	3 No. 5	0.392	8122	8985	10 820
. . .	3 No. 6	0.349	6728	7412	8980
. . .	3 No. 7	0.311	5559	6102	7413
. . .	3 No. 8	0.277	4592	5023	6099
. . .	3 No. 9	0.247	3781	4122	4950
. . .	3 No. 10	0.220	3127	3407	4039
. . .	3 No. 12	0.174	1647	1719	2564

[A] Diameter of circumscribing circle.

[B] Minimum breaking strength is calculated using the minimum diameter of the individual wire and the minimum tensile strength from B227. Breaking loads of 7-wire and 19-wire conductors are taken as 90 % of the sum of the breaking loads of the individual wires; breaking load of 3-wire conductors is taken as 95 % of the sum of the breaking loads of the individual wires.

[C] The designation "Inch" is the approximate diameter in proper fraction of an inch.

[D] The designation of "AWG" is a combination of the number of wires each of the American Wire Gage size indicated by "No."

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stranded conductor below the minimum breaking strength shown in Table 1. Such joints or splices shall be not closer than 50 ft (15 m) to any other joint in the same layer in the conductor (Note 1).

NOTE 1—Joints or splices in individual copper-clad steel wires in their finished size are made by electrical butt welding. Two types of joints are used and are described as follows:

(a) Weld-Annealed Joints—After butt welding, the wire is annealed for a distance of approximately 5 in. (127 mm) on each side of the weld. The weld is then protected from corrosion with a snug fitting seamless copper sleeve which extends at least 3/8 in. (9.5 mm) on each side of the weld and which is thoroughly sealed to the wire with solder. The wall thickness of the sleeve is at least 10 % of the radius of the wire.

This joint has a tensile strength of approximately 60 000 psi (415 MPa). This is less than the strength of the individual wires, but an allowance is made for this in the rated strength of the conductor as a whole. The completed conductor when containing such joints is required to have the full rated strength.

This type of joint is but slightly larger than the wire itself and is applicable for 7, 12, and 19-wire stranded conductors.

(b) Compression-Weld Joints—Compression-weld joints differ from weld-annealed joints in that the wire is not annealed after the butt-welding operation but is reinforced with a hard-drawn, seamless, silicon-tin bronze sleeve which is applied by means of a hydraulic compressor over the weld. This sleeve is covered with solder so as to completely seal the ends. These sleeves have a wall thickness of 25 to 50 % of the radius of the wire, depending on the wire size. Their use is usually limited to 3-wire conductors where the relatively large diameter is not objectionable. This joint develops the full strength of the wire.

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6. Lay

6.1 For 3-wire conductors the preferred lay is 16½ times the outside diameter, but the lay shall not be less than 14 times nor more than 20 times this diameter.

6.2 For 7- and 19-wire conductors the preferred lay is 13½ times the diameter of that layer, but the lay shall not be less than 10 nor more than 16 times this diameter.

6.3 The direction of lay of the outer layer shall be left-hand unless the direction of lay is specified otherwise by the purchaser.

TABLE 2 Density of Copper-Clad Steel

Units	Grade 40 Density at 20°C	Grade 30 Density at 20°C
Grams per cubic centimetre	8.24	8.15
Pounds per cubic inch	0.2975	0.2944
Pounds per circular mil-foot	0.0000028039	0.0000027750