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# Standard Specification for Modified Concentric-Lay-Stranded Copper Conductors for Use in Insulated Electrical Cables<sup>1</sup>

This standard is issued under the fixed designation B784; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers bare modified concentric-lay-stranded conductors made from round copper wires, either uncoated or coated with tin, lead, or lead alloy for general use in insulated electrical cables. These conductors shall be constructed with a central core consisting of not more than seven wires, surrounded by one or more layers of helically laid wires.

1.2 For the purposes of this specification, conductors are classified as follows (Explanatory [Note 1](#) and [Note 2](#)):

1.2.1 *Class B Modified*—Conductors to be insulated with various materials such as rubber, paper, and crosslink polyethylene.

1.2.2 *Class C Modified and Class D Modified*—Conductors where greater flexibility is required than is provided by Class B Modified conductors.

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 the values from the two systems may result in non-conformance with the specification. For conductor sizes designated by AWG or kcmil sizes, the requirements in SI units are numerically converted from the corresponding requirements in inch-pound units. 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.

NOTE 1—The significant differences in this specification from Specification [B8](#) are as follows: (1) The central core is permitted to contain up to seven wires drawn into the assembly with an infinite length of lay while

<sup>1</sup> 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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Specification [B8](#) permits only one, and (2) The construction is applicable only to stranded assemblies of 19 or more wires.

## 2. Referenced Documents

2.1 The following documents of the issue in effect at the date of material purchase form a part of this specification to the extent referenced herein.

2.2 *ASTM Standards*:<sup>2</sup>

[B3](#) Specification for Soft or Annealed Copper Wire

[B8](#) Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

[B33](#) Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

[B189](#) Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes

[B263](#) Test Method for Determination of Cross-Sectional Area of Stranded Conductors

[B354](#) Terminology Relating to Uninsulated Metallic Electrical Conductors

2.3 *Other Standard*:

[NBS Handbook 100](#)<sup>3</sup>

## 3. Ordering Information

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

3.1.1 Quantity of each size and class,

3.1.2 Conductor size: circular-mil area or American Wire Gage (AWG) (Section [6](#)),

3.1.3 Class (see [1.2](#) and [Table 1](#)),

3.1.4 Temper (see [10.2](#)),

3.1.5 Whether coated or uncoated; if coated, designate type of coating (see [10.1](#) and [10.2](#)),

3.1.6 Details of special-purpose lays, if required (see [5.2](#)),

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, <http://www.ntis.gov>.

**TABLE 1 Construction Requirements of Modified Concentric-Lay-Stranded Copper Conductors**

NOTE 1—See Explanatory Note 5.

Circular Mils	Size American Wire Gage	Class B Modified			Class C Modified			Class D Modified		
		Number of Wires	Diameter		Number of Wires	Diameter		Number of Wires	Diameter	
			(mils)	(mm)		(mils)	(mm)		(mils)	(mm)
5 000 000 <sup>A</sup>		217	151.8	3.86	271	135.8	3.45	271	135.8	3.45
4 000 000		217	144.0	3.66	271	128.9	3.27	271	128.9	3.27
4 000 000		217	135.8	3.45	271	121.5	3.09	271	121.5	3.09
3 500 000		169	143.9	3.66	217	127.0	3.23	271	113.6	2.89
3 000 000 <sup>A</sup>		169	133.2	3.38	217	117.6	2.99	271	105.2	2.67
2 500 000 <sup>A</sup>		127	140.3	3.56	169	121.6	3.09	217	107.3	2.73
2 000 000 <sup>A</sup>		127	125.5	3.19	169	108.8	2.76	217	96.0	2.44
1 900 000		127	122.3	3.11	169	106.0	2.69	217	93.6	2.38
1 800 000		127	119.1	3.03	169	103.2	2.62	217	91.1	2.31
1 750 000 <sup>A</sup>		127	117.4	2.98	169	101.8	2.59	217	89.8	2.28
1 700 000		127	115.7	2.94	169	100.3	2.55	217	88.5	2.25
1 600 000		127	112.2	2.85	169	97.3	2.47	217	85.9	2.18
1 500 000 <sup>A</sup>		91	128.4	3.26	127	108.7	2.76	169	94.2	2.39
1 400 000		91	124.0	3.15	127	105.0	2.67	169	91.0	2.31
1 300 000		91	119.5	3.04	127	101.2	2.57	169	87.7	2.23
1 250 000		91	117.2	2.98	127	99.2	2.52	169	86.0	2.18
1 200 000		91	114.8	2.92	127	97.2	2.47	169	84.3	2.14
1 100 000		91	109.9	2.79	127	93.1	2.36	169	80.7	2.05
1 000 000 <sup>A</sup>		61	128.0	3.25	91	104.8	2.66	127	88.7	2.25
900 000		61	121.5	3.09	91	99.4	2.52	127	84.2	2.14
800 000 <sup>A</sup>		61	114.5	2.91	91	93.8	2.38	127	79.4	2.02
750 000 <sup>A</sup>		61	110.9	2.82	91	90.8	2.31	127	76.8	1.95
700 000 <sup>A</sup>		61	107.1	2.72	91	87.7	2.23	127	74.2	1.88
650 000		61	103.2	2.62	91	84.5	2.15	127	71.5	1.82
600 000 <sup>A</sup>		61	99.2	2.52	91	81.2	2.06	127	66.7	1.69
550 000		61	95.0	2.41	91	77.7	1.97	127	65.8	1.67
500 000 <sup>A</sup>		37	116.2	2.95	61	90.5	2.30	91	74.1	1.88
450 000		37	110.3	2.80	61	85.9	2.18	91	70.3	1.79
400 000 <sup>A</sup>		37	104.0	2.64	61	81.0	2.06	91	66.3	1.68
350 000 <sup>A</sup>		37	97.3	2.47	61	75.7	1.92	91	62.0	1.57
300 000 <sup>A</sup>		37	90.0	2.29	61	70.1	1.78	91	57.4	1.46
250 000 <sup>A</sup>		37	82.2	2.09	61	64.0	1.63	91	52.4	1.33
211 000 <sup>A</sup>	0000	19	105.5	2.68	37	75.6	1.92	61	58.9	1.50
167 000 <sup>A</sup>	000	19	94.0	2.39	37	67.3	1.71	61	52.4	1.33
133 000 <sup>A</sup>	00	19	83.7	2.13	37	60.0	1.52	61	46.7	1.19
105 000 <sup>A</sup>	0	19	74.5	1.89	37	53.4	1.36	61	41.6	1.06
83 000 <sup>A</sup>	1	19	66.4	1.69	37	47.6	1.21	61	37.0	0.94

<sup>A</sup> These sizes of conductors provide for one or more schedules of preferred series and commonly are used in the industry. The sizes not marked are given simply as a matter of reference and it is suggested that their use be discouraged.

- 3.1.7 Lagging, if required (see 14.2),
- 3.1.8 Special package marking, if required (Section 13),
- 3.1.9 Place of inspection (Section 12), and

#### 4. Joints

4.1 Welds and brazes may be made in rods or in wires prior to final drawing. Welds and brazes may be made in the finished individual wires composing the conductor, but shall not be closer together than prescribed in Table 2.

#### 5. Lay

5.1 The lay of a layer of wires shall be not less than eight nor more than sixteen times the outside diameter of that layer, except that for conductors composed of 37 wires or more, this

requirement shall apply only to the two outer layers. The lay of the layers other than the two outer layers shall be at the option of the manufacturer, unless otherwise agreed upon.

5.2 Other lays for special purposes shall be furnished by special agreement between the manufacturer and the purchaser (Explanatory Note 3).

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

5.4 The direction of lay shall be reversed in successive layers, unless otherwise specified by the purchaser.

#### 6. Construction

6.1 The areas of cross section, numbers, and diameters of wires in the various classes of concentric-lay-stranded conductors shall conform to the requirements prescribed in Table 1.

6.2 The diameters of the wires listed in Table 1 are nominal. Where “combination strand” is required in order to insulate the conductor properly (strands in the outer layer having a larger diameter than those in the inner layers) the diameters shall be subject to a tolerance of  $\pm 5\%$ , provided that the area of cross section after stranding is in accordance with Section 11.

**TABLE 2 Minimum Distance Between Joints in the Completed Conductor**

Number of Wires in Conductor	Soft All Classes
19	1 ft
20 and over	1 ft in a layer <sup>A</sup>

<sup>A</sup> Except as indicated, the limitations apply to closeness of joints throughout the completed conductor.