



## Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation<sup>1</sup>

This standard is issued under the fixed designation B 787/B 787M; 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 combination unilay-stranded conductors made from round copper wires, either uncoated or coated with tin or lead alloy for insulated conductors for electrical purposes. These conductors shall be constructed with a central core wire surrounded by two layers of helically laid wires, resulting in an outer diameter equal to the compressed-stranded equivalent conductor. (See Explanatory Note 1 and Note 2).

NOTE 1—For the purpose of this specification, combination unilay conductor is defined as follows: a central core wire surrounded by a layer of six helically laid wires of the same diameter as the core wire with a helically laid outer layer containing six smaller wires alternated between six wires of the same diameter as the wires in the layer underneath. Both layers have a common length and direction of lay (see Fig. 1).

1.2 For the purpose of this specification, normal conductor classification (Class AA, A, B, C) is not applicable as these conductors are intended for subsequent insulation. The descriptive term combination unilay-stranded shall be used in place of conductor classification.

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

#### 2.2 ASTM Standards:

B 1 Specification for Hard-Drawn Copper Wire<sup>2</sup>

<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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<sup>2</sup> *Annual Book of ASTM Standards*, Vols 02.03.

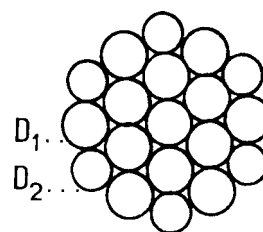


FIG. 1 Cross Section of Conductor

B 2 Specification for Medium-Hard-Drawn Copper Wire<sup>2</sup>

B 3 Specification for Soft or Annealed Copper Wire<sup>2</sup>

B 33 Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes<sup>2</sup>

B 189 Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes<sup>2</sup>

B 246 Specification for Tinned Hard-Drawn and Medium-Hard-Drawn Copper Wire for Electrical Purposes<sup>2</sup>

B 263 Test Method for Determination of Cross-Sectional Area of Stranded Conductors<sup>2</sup>

B 354 Terminology Relating to Uninsulated Metallic Electrical Conductors<sup>2</sup>

#### 2.3 Other Standard:

NBS Handbook 100—Copper Wire Tables of the National Bureau of Standards<sup>3</sup>

### 3. Ordering Information

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

3.1.1 Quantity of each size,

3.1.2 Conductor Size: Circular-mil area or American Wire Gage, AWG (Section 7 and Table 1),

3.1.3 Stranding (see Explanatory Note 3),

3.1.4 Temper (see 4.2),

3.1.5 Whether coated or uncoated; if coated, designate type of coating (see 4.1 and 4.2),

3.1.6 Details of special-purpose lays, if required (see 6.2),

3.1.7 When physical tests shall be made (see 9.2 and 9.3),

3.1.8 Package size (see 15.1),

3.1.9 Lagging, if required (see 15.2),

3.1.10 Special package marking, if required (Section 15), and

<sup>3</sup> Available from National Institute of Standards and Technology, (NIST), Gaithersburg, MD 20899.

**TABLE 1 Construction Requirements for 19-Wire Combination Unilay Stranded Copper Conductors**

| Area of Cross Section |       | Size, American (or Brown and Sharpe) Wire Gage | Wire D <sub>1</sub> <sup>A</sup> Diameter, |     | Wire D <sub>2</sub> <sup>B</sup> Diameter, |     |
|-----------------------|-------|--|--|-----|--|-----|
| cmil                  | sq mm |  | mils                                       | mm  | mils                                       | mm  |
| 500 000               | 253.4 |  | 175.6                                      | 4.5 | 128.5                                      | 3.3 |
| 450 000               | 228.0 |  | 166.6                                      | 4.2 | 121.9                                      | 3.1 |
| 400 000               | 202.7 |  | 157.1                                      | 4.0 | 115.0                                      | 2.9 |
| 350 000               | 177.3 |  | 146.9                                      | 3.7 | 107.5                                      | 2.7 |
| 300 000               | 152.0 |  | 136.0                                      | 3.5 | 99.6                                       | 2.5 |
| 250 000               | 126.7 |  | 124.2                                      | 3.2 | 90.9                                       | 2.3 |
| 211 600               | 107.2 | 0000   | 144.2                                      | 3.7 | 83.6                                       | 2.1 |
| 167 800               | 85.0  | 000  | 101.7                                      | 2.6 | 74.5                                       | 1.9 |
| 133 100               | 67.4  | 00   | 90.6                                       | 2.3 | 66.3                                       | 1.7 |
| 105 600               | 53.5  | 0  | 80.7                                       | 2.0 | 59.1                                       | 1.5 |
| 83 690                | 42.4  | 1  | 71.8                                       | 1.8 | 52.6                                       | 1.3 |
| 66 360                | 33.6  | 2  | 64.0                                       | 1.6 | 46.8                                       | 1.2 |
| 52 620                | 26.7  | 3  | 57.0                                       | 1.4 | 41.7                                       | 1.1 |
| 41 740                | 21.1  | 4  | 50.7                                       | 1.3 | 37.1                                       | 0.9 |
| 33 090                | 16.8  | 5  | 45.2                                       | 1.1 | 33.1                                       | 0.8 |
| 26 240                | 13.3  | 6  | 40.2                                       | 1.0 | 29.4                                       | 0.7 |
| 30 820                | 15.6  | 7  | 35.8                                       | 0.9 | 26.2                                       | 0.7 |
| 16 510                | 8.4   | 8  | 31.9                                       | 0.8 | 23.4                                       | 0.6 |
| 13 090                | 6.6   | 9  | 28.4                                       | 0.7 | 20.8                                       | 0.5 |
| 10 380                | 5.3   | 10   | 25.3                                       | 0.6 | 18.5                                       | 0.5 |
| 6 530                 | 3.3   | 12   | 20.1                                       | 0.5 | 14.7                                       | 0.4 |
| 4 110                 | 2.1   | 14   | 15.9                                       | 0.4 | 11.7                                       | 0.3 |
| 2 580                 | 1.3   | 16   | 12.6                                       | 0.3 | 9.2  | 0.2 |
| 1 620                 | 0.8   | 18   | 10.0                                       | 0.3 | 7.3  | 0.2 |
| 1 020                 | 0.5   | 20   | 7.9  | 0.2 | 5.8  | 0.1 |
| 640                   | 0.3   | 22   | 6.3  | 0.2 | 4.6  | 0.1 |
| 404                   | 0.2   | 24   | 5.0  | 0.1 | 3.7  | 0.1 |

<sup>A</sup> Equation to calculate D<sub>1</sub>:

$$D_1 = \sqrt{\frac{\text{Area of Cross Section (cmil)}}{16.2149}}$$

<sup>B</sup> Equation to calculate D<sub>2</sub>: = D<sub>1</sub> × 0.732.

3.1.11 Place of inspection (Section 13).

#### 4. Requirements for Wires

4.1 The purchaser shall designate the type of wire and the kind of coating, if any, to be used in the conductor.

4.2 Before stranding, the copper wire used shall meet all of the requirements of the following ASTM specifications that are applicable to its type:

- 4.2.1 Specification B 3
- 4.2.2 Specification B 33
- 4.2.3 Specification B 2
- 4.2.4 Specification B 1
- 4.2.5 Specification B 189
- 4.2.6 Specification B 246.

4.3 In combination unilay stranded conductors the central core wire shall be made of the same type and temper as the layers, unless otherwise specified.

#### 5. Joints

5.1 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 50 ft (15.24 m) for hard and medium-hard conductors, and 1 ft in a layer for soft conductors.

#### 6. Lay

6.1 For combination unilay conductors the lay of a layer of wires shall be not less than 8 nor more than 16 times the outside diameter of the outer layer.

6.2 Other lays for special purposes shall be furnished by special agreement between the manufacturer and the purchaser (Explanatory Note 4).

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

#### 7. Construction (Explanatory Note 3)

7.1 The areas of cross section, numbers, and diameters of wires in the various conductors shall conform to the requirements prescribed in Table 1.

7.2 The diameters of the wires listed in Table 2 are nominal. In order to produce an essentially round 19-wire construction, the outer 12-wire layer in the combination unilay product is comprised of 6 wires of the same diameter as the wires in the 7-wire core, and 6 wires approximately 25 % smaller. The 2-wire sizes are alternated around the 7-wire core (Fig. 1).

#### 8. Physical and Electrical Tests of Conductors Stranded of Soft Wires

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 complete stranded conductor, but need not be made upon both. Care shall be taken to avoid mechanical injury to wire removed 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 4.2.

8.4 The physical properties of wires removed from the completed stranded conductor shall be permitted to vary from the applicable requirements of 4.2 by the amounts as follows (Explanatory Note 5):

8.4.1 *Average of Results Obtained on All Wires Tested*—The minimum elongation required shall be reduced in numerical value 5 (for example, from 30 to 25 %) from the numerical requirements for the wire before stranding.

8.4.2 *Results Obtained on Individual Wires*—The elongation of individual wires shall be reduced in numerical value 15 from the minimum requirements before stranding (that is, 10 in addition to the 5 allowed in 8.4.1), but in no case shall the elongation of any individual wire be less than 5 %.

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 the conductor shall be tested for the purpose of final determination of 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 or lead-alloy-coating test is required, it shall be made on the wires prior to stranding.

#### 9. Physical and Electrical Tests of Conductors Stranded of Hard-Drawn or Medium-Hard Drawn Wires

9.1 Tests for the physical and electrical properties of wires composing conductors made from hard-drawn or medium-hard-drawn wires, uncoated or coated, shall be made before but not after stranding.

9.2 At the option of the purchaser, tension and elongation