



## Standard Specification for Free-Cutting Copper Rod, Bar, Wire, and Shapes<sup>1</sup>

This standard is issued under the fixed designation B 301/B 301M; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope\*

1.1 This specification establishes the requirements for free-cutting copper rod, bar, wire, and shapes of UNS Alloy Nos. C14500, C14510, C14520, C14700, and C18700, suitable for high-speed screw machine work or for general applications.

1.2 Typically, product made to this specification is furnished as straight lengths. Sizes  $\frac{1}{2}$  in. [12 mm] and under may be furnished in coils when requested.

1.3 *Units*—The values stated in either inch-pound or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values stated 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 this specification.

### 2. Referenced Documents

#### 2.1 *ASTM Standards*:<sup>2</sup>

- B 193 Test Method for Resistivity of Electrical Conductor Materials
- B 249/B 249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings
- B 250/B 250M Specification for General Requirements for Wrought Copper-Alloy Wire
- E 8 Test Methods for Tension Testing of Metallic Materials
- E 8M Test Methods for Tension Testing of Metallic Materials
- E 121 Test Methods for Chemical Analysis of Copper-Tellurium Alloys
- E 478 Test Methods for Chemical Analysis of Copper Alloys

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.02 on Rods, Bar, Wire, Shapes, and Forgings.

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<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.

### 3. General Requirements

3.1 The following sections of Specifications B 249/B 249M or B 250/B 250M constitute a part of this specification.:

- 3.1.1 Terminology,
- 3.1.2 Materials and Manufacture,
- 3.1.3 Dimensions and Permissible Variations,
- 3.1.4 Workmanship, Finish, and Appearance,
- 3.1.5 Sampling,
- 3.1.6 Number of Tests and Retests,
- 3.1.7 Specimen Preparation,
- 3.1.8 Test Methods,
- 3.1.9 Inspection,
- 3.1.10 Significance of Numerical Limits,
- 3.1.11 Rejection and Rehearing,
- 3.1.12 Certification,
- 3.1.13 Test Reports,
- 3.1.14 Packaging and Package Marking, and
- 3.1.15 Supplementary Requirements.

3.2 In addition, when a section with a title identical to that referenced in 3.1 appears in this specification, it contains additional requirements which supplement those appearing in Specifications B 249/B 249M or B 250/B 250M.

### 4. Ordering Information

4.1 Include the following information in orders for products:

- 4.1.1 ASTM designation and year of issue,
- 4.1.2 Copper UNS No. designation,
- 4.1.3 Product (rod, bar, wire, or shape),
- 4.1.4 Cross section (round, hexagonal, square, and so forth),
- 4.1.5 Temper (Section 6),
- 4.1.6 Dimensions, diameter or distance between parallel surfaces; width and thickness,
- 4.1.7 How furnished: straight lengths, coils, or reels,
- 4.1.8 Length (Section 9.3),
- 4.1.9 Total length, or number of pieces of each size,
- 4.1.10 Total weight of each size, and
- 4.1.11 When product is purchased for agencies of the U.S. government (Specifications B 249/B 249M or B 250/B 250M).

4.2 The following options are available and should be specified at the time of placing of the order when required:

\*A Summary of Changes section appears at the end of this standard.

- 4.2.1 Certification (Specifications B 249/B 249M or B 250/B 250M),
- 4.2.2 Mill Test Reports (Specifications B 249/B 249M or B 250/B 250M),
- 4.2.3 Yield strength tests (Section 8),
- 4.2.4 Resistivity tests (Section 7), and
- 4.2.5 Automatic screw machine use (9.4).

## 5. Chemical Composition

5.1 The material shall conform to the chemical composition requirements in Table 1 for the UNS No. designation specified in the ordering information.

5.2 These composition limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements by agreement between the manufacturer and the purchaser.

## 6. Temper

6.1 The standard tempers for products described in this specification are given in Table 2.

6.1.1 Rod (round, hexagonal, and octagonal) shall be furnished in H02 (half-hard) temper for general use and applications involving moderate cold forming and in H04 (hard) temper (round only) for applications that require maximum strength and resistance to bending under cutting-tool pressure.

6.1.2 Bar shall be furnished in H04 (hard) temper only.

6.1.3 Wire shall be furnished in H02 (half-hard) or H04 (hard) temper.

6.2 Other tempers, and temper for other products including shapes, shall be subject to agreement between the manufacturer and the purchaser.

## 7. Physical Property Requirements

### 7.1 Electrical Requirements:

7.1.1 The product produced from Copper UNS Nos. C14500, C14520, C14700, and C18700 shall conform to the following electrical requirements, when tested in accordance with Test Method B 193, at a temperature of 68°F [20°C].

| UNS No. | Resistivity, max, $\Omega$ , g/m <sup>2</sup> | Conductivity, min, % IACS <sup>A</sup> |
|---------|---|--|
| C14500  | 0.180 33                                      | 85.0                                   |
| C14520  | 0.204 37                                      | 75.0                                   |
| C14700  | 0.170 30                                      | 90.0                                   |
| C18700  | 0.170 30                                      | 90.0                                   |

<sup>A</sup> International Annealed Copper Standard.

7.1.2 Copper UNS No. C14510 is not intended for electrical applications. This alloy, therefore, has no electrical requirements.

7.1.3 Electrical resistivity tests need not be made except when indicated by the purchaser at the time of placing the order. The electrical resistivity tests shall be made on annealed test specimens.

## 8. Mechanical Property Requirements

8.1 The product shall conform to the tensile strength and elongation requirements of Table 2 when tested in accordance with Test Methods E 8 and E 8M.

8.2 When specified in the contract or purchase order, the yield strength shall be determined and conform with the yield strength requirements of Table 2 when tested in accordance with Test Methods E 8 and E 8M.

## 9. Dimensions, Mass, and Permissible Variations

9.1 The dimensions and tolerances for material described by this specification shall be as specified in Specifications B 249/B 249M or B 250/B 250M with particular reference to the following tables and related paragraphs in those specifications.

### 9.2 Diameter or Distance Between Parallel Surfaces:

9.2.1 Rod (Round, Hexagonal, and Octagonal)—See 6.2 and Table 1 of Specification B 249/B 249M.

9.2.2 Bar (Rectangular and Square)—See 6.2 and Tables 7 and 10 of Specification B 249/B 249M.

9.2.3 Wire—See 6.2 and Table 1 of Specification B 250/B 250M.

9.3 Lengths—H04 (hard) temper bar, unless otherwise specified, and all rod shall be furnished in straight lengths. See 6.3 and Tables 13 and 14 of Specification B 249/B 249M.

9.4 Straightness—See 6.4 and Table 16 of Specification B 249/B 249M.

**TABLE 1 Chemical Requirements**

| Element              | Composition, %                 |                        |                        |                        |                       |
|----------------------|--------------------------------|------------------------|------------------------|------------------------|-----------------------|
|                      | Copper or Copper Alloy UNS No. |                        |                        |                        |                       |
|                      | C14500 <sup>A</sup>            | C14510                 | C14520                 | C14700 <sup>A</sup>    | C18700                |
| Tellurium            | 0.40–0.7                       | 0.30–0.7               | 0.40–0.7               | ...                    | ...                   |
| Sulfur               | ...                            | ...                    | ...                    | 0.20–0.50              | ...                   |
| Lead                 | ...                            | 0.05 max               | ...                    | ...                    | 0.8–1.5               |
| Phosphorus           | 0.004–0.012                    | 0.010–0.030            | 0.004–0.020            | 0.002–0.005            | ...                   |
| Copper (incl silver) | 99.90 min <sup>B</sup>         | 99.85 min <sup>B</sup> | 99.90 min <sup>B</sup> | 99.90 min <sup>C</sup> | 99.5 min <sup>D</sup> |

<sup>A</sup> Includes oxygen-free or deoxidized grades with deoxidizers (such as phosphorus, boron, lithium, or other) in an amount agreed upon.

<sup>B</sup> Includes tellurium.

<sup>C</sup> Includes sulfur and phosphorus.

<sup>D</sup> Includes lead.

**TABLE 2 Tensile Requirements**

| Temper Designation             |           | Diameter or Distance Between Parallel Surfaces, <sup>A</sup> in. [mm] | Tensile Strength, min |     | Yield Strength at 0.5 % Extension Under Load, <sup>B</sup> min |     | Elongation in 4× diameter or thickness of specimen, <sup>C</sup> min, % |
|--------------------------------|-----------|---|-----------------------|-----|--|-----|---|
| Standard                       | Former    |   | ksi                   | MPa | ksi  | MPa |   |
| HO2                            | half-hard | Rod:  |                       |     |  |     |   |
|                                |           | 1/16 to 1/4 [1.5 to 6.5], incl  | 38                    | 260 | 30   | 205 | 8   |
|                                |           | over 1/4 to 2 5/8 [6.5 to 67], incl                                   | 38                    | 260 | 30   | 205 | 12  |
| HO4                            | hard      | Wire:   |                       |     |  |     |   |
|                                |           | 1/16 to 1/2 [1.5 to 12], incl   | 38                    | 260 |  |     | 6   |
|                                |           | Rod (round only):   |                       |     |  |     |   |
|                                |           | 1/16 to 1/4 [1.5 to 6.5], incl  | 48                    | 330 | 40   | 275 | 4   |
|                                |           | over 1/4 to 1 1/4 [6.5 to 32], incl                                   | 44                    | 305 | 38   | 260 | 8   |
|                                |           | over 1 1/4 to 3 [32 to 76], incl                                      | 40                    | 275 | 35   | 240 | 8   |
|                                |           | Bar:  |                       |     |  |     |   |
|                                |           | over 0.188 to 3/8 [5 to 10], incl                                     | 42                    | 290 | 35   | 240 | 10  |
|                                |           | over 3/8 to 1/2 [10 to 12], incl                                      | 40                    | 275 | 32   | 220 | 10  |
| over 1/2 to 2 [12 to 50], incl | 33        | 225   | 18                    | 125 | 12   |     |   |
| over 2 to 4 [50 to 100], incl  | 32        | 220   | 15                    | 105 | 12   |     |   |
| Wire:                          |           |   |                       |     |  |     |   |
| 1/16 to 1/2 [1.5 to 12], incl  | 48        | 330   | ...                   | ... | 4  |     |   |

<sup>A</sup> For rectangular bar, the Distance Between Parallel Surfaces refers to thickness.

<sup>B</sup> Not determined unless specifically requested.

<sup>C</sup> In any case, a minimum gage length of 1 in. [25 mm] shall be used.

9.4.1 General use straightness tolerances will apply unless rod is specified for automatic screw machine use at the time of placing the order.

9.5 *Edge Contours*—See 6.5 of Specification B 249/B 249M.

## 10. Test Methods

### 10.1 Chemical Analysis:

10.1.1 Composition shall be determined, in case of disagreement, as follows:

| Element    | Test Methods |
|------------|--------------|
| Copper     | E 478        |
| Phosphorus | E 478        |
| Tellurium  | E 121        |
| Lead       | E 478        |

## 11. Keywords

11.1 free-cutting copper rod and bar; free-cutting copper wire; lead-bearing copper rod and bar; screw machine work; tellurium-bearing copper rod and bar; UNS No. C14500; UNS No. C14510; UNS No. C14520; UNS No. C14700; UNS No. C18700

## SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue (B 301/B 301M – 99) that may impact the use of this standard. (Approved May 1, 2004.)

- |  |  |
|--|--|
| (1) Updated references to B 249/B 249M and B 250/B 250M.             | (4) Clarified rod straightness tolerances. |
| (2) Revised Table 1 to conform with UNS Standard Alloy Designations. | (5) Added alloy numbers to keywords.       |
| (3) Clarified size ranges for bar in Table 2 with an added footnote. |  |

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