



Designation: **B 301/B 301M – 9904**

Standard Specification for Free-Cutting Copper Rod, Bar, Wire, and Shapes¹

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 (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 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.

¹ 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.

Current edition approved ~~Sept. 10, 1999~~, May 1, 2004. Published ~~November 1999~~, May 2004. Originally published as ~~B 301—55T~~, approved in 1955. Last previous edition approved in 1999 as B 301/B 301M – 969.

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

2. Referenced Documents

2.1 ASTM Standards:²

- 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 249~~B 250M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes, and Forgings [Metric]³
- ~~B 250~~ Specification for General Requirements for Wrought Copper-Alloy Wire³
- ~~B 250M~~ Specification for General Requirements for Wrought Copper-Alloy Wire [Metric]³ 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

3. General Requirements

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

- 3.1.1 Terminology₂
- 3.1.2 Materials and Manufacture₂
- 3.1.3 Dimensions and Permissible Variations₂
- 3.1.4 Workmanship, Finish, and Appearance₂
- 3.1.5 Sampling₂
- 3.1.6 Number of Tests and Retests₂
- 3.1.7 Specimen Preparation₂
- 3.1.8 Test Methods₂
- 3.1.9 Inspection₂
- 3.1.10 Significance of Numerical Limits₂
- 3.1.11 Rejection and Rehearing₂
- 3.1.12 Certification₂
- 3.1.13 Test Reports₂
- 3.1.14 Packaging and Package Marking₂, 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, B 250,~~ 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 (B 249, B 249M, B 250,~~ 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:

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

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*, Vol 02.03, volume information, refer to the standard's Document Summary page on the ASTM website.

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 -20°C (-68°F), 20°C .

TABLE 1 Chemical Requirements

Element	Composition, %				
	Copper or Copper Alloy UNS No.				
	C14500 ^A	C14510	C14520	C14700 ^A	C18700
Tellurium	0.40–0.7	0.30–0.7	0.40–0.7	...	...
Sulfur	...	...	...	0.20–0.50	...
Lead	...	0.05	...	...	0.8–1.5
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 ^B	99.85 min ^B	99.90 min ^B	99.90 ^C	99.5 min ^D
Copper (incl silver)	99.90 min ^B	99.85 min ^B	99.90 min ^B	99.90 min ^C	99.5 min ^D

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

^B Includes tellurium.

^C Includes sulfur and phosphorus.

^D Includes lead.

TABLE 2 Tensile Requirements

Temper Designation		Diameter or Distance Between Parallel Surfaces, ^A in. [mm]	Tensile Strength, min		Yield Strength at 0.5 % Extension Under Load, ^{A,B} min		Elongation in 4× diameter or thickness of specimen, ^{B,C} 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 23/16 [6.5 to 67], incl	38	260	30	205	12	
		Wire:						
		1/16 to 1/2 [1.5 to 12], incl	38	260			6	
HO4	hard	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

^A—For drawn rectangular bar, the Distance Between Parallel Surfaces refers to thickness.

^B—Not determined unless specifically requested.

^C—In any case, a minimum gage length of 1 in. [25 mm] shall be used.

UNS No.	Resistivity, max, Ω , g/m ²	Conductivity, min, % IACS ^A
C14500	0.180 33	85.0
C14520	0.204 37	75.0
C14700	0.170 30	90.0
C18700	0.170 30	90.0

^A 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, B 250, 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 Specifications B 249 or B 249M.

9.2.2 *Bar (Rectangular and Square)*—See 6.2 and Tables 7 and 10 of Specifications B 249 or B 249M.

9.2.3 *Wire*—See 6.2 and Table 1 of Specifications B 250 or 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 Specifications B 249 or B 249M.

9.4 *Straightness*— See 6.4 and Table 16 of Specifications B 249 or B 249M.

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 Specifications B 249 or 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 specification standard since the last issue (~~B 301–96~~) [~~B 301M–96~~]; (B 301/B 301M – 99) that may impact the use of this standard. (Approved May 1, 2004.)

- (1) ~~Combined customary inch-pound~~ Updated references to B 249/B 249M and SI unit specifications into a single document. B 250/B 250M.
- (2) ~~Scope revised and wire product added.~~ Revised Table 1 to conform with UNS Standard Alloy Designations.
- (3) ~~Wire tempers added to Section 6 and Clarified size ranges for bar in Table 2 with an added footnote.~~
- (4) ~~Wire tolerances added to Section 9.~~ Clarified rod straightness tolerances.
- (5) ~~Test methods for chemical analysis added as Section 10.~~ Added alloy numbers to keywords.

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