



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

This standard is issued under the fixed designation B301/B301M; 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 SI units or inch-pound units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

2. Referenced Documents

2.1 ASTM Standards:²

[B193 Test Method for Resistivity of Electrical Conductor Materials](#)

[B249/B249M Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, Shapes and Forgings](#)

[B250/B250M Specification for General Requirements for Wrought Copper Alloy Wire](#)

[B950 Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E121 Test Methods for Chemical Analysis of Copper-](#)

[Tellurium Alloys](#) (Withdrawn 2010)³

[E478 Test Methods for Chemical Analysis of Copper Alloys](#)

3. General Requirements

3.1 The following sections of Specifications [B249/B249M](#) or [B250/B250M](#) 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 [B249/B249M](#) or [B250/B250M](#).

4. Ordering Information

4.1 Include the following specified choices when placing orders for products under this specification, as applicable:

- 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,

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 Rod, Bar, Wire, Shapes and Forgings.

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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 The last approved version of this historical standard is referenced on www.astm.org.

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



4.1.10 Total weight of each size, and

4.1.11 Intended application.

4.2 The following options are available but may not be included unless specified at the time of placing of the order when required:

4.2.1 Certification (Specifications **B249/B249M** or **B250/B250M**),

4.2.2 Mill Test Reports (Specifications **B249/B249M** or **B250/B250M**),

4.2.3 Yield strength tests (Section 8),

4.2.4 Resistivity tests (Section 7),

4.2.5 Automatic screw machine use (9.4), and

4.2.6 When product is purchased for agencies of the U.S. Government (Specifications **B249/B249M** or **B250/B250M**).

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 **B193**, at a temperature of 68°F [20°C].

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 **E8/E8M**.

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 **E8/E8M**.

9. Dimensions, Mass, and Permissible Variations

9.1 The dimensions and tolerances for product described by this specification shall be as specified in Specifications **B249/B249M** or **B250/B250M** 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 **B249/B249M**.

9.2.2 Bar (Rectangular and Square)—See 6.2 and Tables 7 and 10 of Specification **B249/B249M**.

9.2.3 Wire—See 6.2 and Table 1 of Specification **B250/B250M**.

9.3 Lengths—H04 (hard) temper bar, unless otherwise specified, all rod shall be furnished in straight lengths. See 6.3 and Tables 13 and 14 of Specification **B249/B249M**.

9.4 Straightness—See 6.4 and Table 16 of Specification **B249/B249M**.

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 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 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 and phosphorus.

^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, ^B min		Elongation in 4× diameter or thickness of specimen, ^C min, %
Code	Name		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

^A For 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.

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 B249/B249M.

10. Test Methods

10.1 Chemical Analysis:

10.1.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and purchaser. The following table is a list of published test methods some of which are considered by ASTM as no longer viable. These, and others not listed, may be used subject to agreement.

Element	Test Methods
Copper	E478
Phosphorus	E478
Tellurium	E121
Lead	E478

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 principal changes to this specification that have been incorporated since the 2008 issue as follows:

(I) Revised sections editorially per Guide B950.

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