



Designation: B16/B16M – 19

# Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines<sup>1</sup>

This standard is issued under the fixed designation B16/B16M; 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 U.S. Department of Defense.*

## 1. Scope\*

1.1 This specification establishes the requirements for free-cutting brass rod, bar, wire, and shapes of any specified cross section produced from Copper Alloy UNS Nos. C36000 or C36010 suitable for high-speed screw machining applications and moderate thread rolling.

1.2 *Units*—Values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other and values from the two systems shall not be combined.

1.2.1 Within the text, SI units are shown in brackets.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

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

**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

**B601** Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

**E8/E8M** Test Methods for Tension Testing of Metallic Materials

**E18** Test Methods for Rockwell Hardness of Metallic Materials

**E478** Test Methods for Chemical Analysis of Copper Alloys

## 3. General Requirements

3.1 The following sections of Specifications **B249/B249M** (rod, bar, and shapes), and **B250/B250M** (wrought copper alloy wire) constitute a part of this specification.

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

3.2 In addition, when a section with a title identical to those referenced in 3.1 appears in this specification, it contains additional requirements that supplement those appearing in Specifications **B249/B249M** and **B250/B250M**.

## 4. Ordering Information

4.1 Include the following information when placing orders for product under this specification, as applicable:

4.1.1 ASTM specification designation and year of issue (B16/B16M – XX).

4.1.2 Copper Alloy UNS No. designations (C36000 or C36010, see Section 6 and Table 1). Unless otherwise specified, the alloy supplied will be C36000.

<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 Rod, 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.



**TABLE 1 Chemical Requirements  
Copper Alloy UNS No. C36000 and C36010**

Element	Composition, %	
	Copper Alloy UNS No.	
	C36000	C36010
Copper	60.0 to 63.0	60.0 to 63.0
Lead	2.5 to 3.0	3.1 to 3.7
Iron, max	0.35	0.35
Zinc	Remainder	Remainder

4.1.3 Temper (see Section 7 and Tables 2-5).

4.1.4 Product cross section form (for example, round, hexagonal, square, etc.).

4.1.5 Dimensions (see Section 9).

4.1.6 How furnished: straight lengths or coils (see 5.2).

4.1.7 Edge contours (see Section 9).

4.1.8 Quantity; total weight, footage, or number of pieces for each size.

4.1.9 When product is purchased for applications requiring thread rolling (see 1.1, Tables 2-5).

4.1.10 When product is purchased for agencies of the U.S. Government (see Section 11).

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

4.2.1 Tensile test for product ½ in. [12 mm] and over (see 8.2.1).

4.2.2 Certification (refer to Specifications B249/B249M or B250/B250M).

4.2.3 Mill Test Report (refer to Specifications B249/B249M or B250/B250M).

## 5. Materials and Manufacture

5.1 *Material*—The material of manufacture shall be a cast billet of Copper Alloy UNS No. C36000 or C36010 and of such purity and soundness as to be suitable for hot extrusion into rod, bar, wire, and shaped products.

5.1.1 In the event that heat identification or traceability is required, the purchaser shall specify the details desired.

NOTE 1—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

5.2 *Manufacture*—Product produced under this specification shall be in straight lengths; however, it shall be furnished in coils when so specified in the contract or purchase order (see 4.1.6).

## 6. Chemical Composition

6.1 The product shall conform to the chemical compositional requirements specified in Table 1 for Copper Alloy UNS No. C36000 or C36010.

6.2 The UNS designated composition limits do not preclude the possible presence of other unnamed elements; however, analysis shall be made regularly only for the minor elements listed in Table 1, plus either copper or zinc, or plus all major elements except one. The major element that is not analyzed shall be determined by difference between the sum of those elements analyzed and 100 %. By agreement between producer

or supplier and purchaser, analysis may be required and limits established for the elements not cited. Percentage content of elements shown as “remainder” (rem.) is calculated by difference.

6.3 When all elements in Table 1 are analyzed, their sum shall be 99.5 % min.

## 7. Temper

7.1 Tempers, as defined in Classification B601, identified in Tables 2-5 for product produced under this specification, are as follows:

7.1.1 O60 (soft anneal).

7.1.2 H02 (half hard).

7.1.3 H04 (hard).

7.2 Rod and bar shall be furnished in the H02 (half hard) temper, unless otherwise specified in the ordering information (see 4.1.3).

## 8. Mechanical Property Requirements

8.1 *Rockwell Hardness*:

8.1.1 Product ½ in. [12 mm], and over in diameter or distance between parallel surfaces, shall conform with the requirements given in Table 4 and Table 5 for temper, size, and form when tested in accordance with Test Methods E18.

8.1.1.1 Rockwell hardness shall be the acceptance criterion for sizes ½ in. [12 mm], or greater, based upon mechanical properties, except when tensile requirements are specified as the acceptance criteria in the ordering information.

8.2 *Tensile Requirements*:

8.2.1 When tensile requirements are specified, the product shall conform to the requirements given in Table 2 and Table 3 for temper, size, and form.

8.2.1.1 Tensile requirements shall be the acceptance criteria of mechanical properties for product under ½ in. [12 mm] in diameter or distance between parallel surfaces when tested in accordance with Test Methods E8/E8M.

8.2.1.2 When specified in the ordering information, tensile requirements shall be the acceptance criteria based upon mechanical properties for product ½ in. [12 mm], or greater in diameter or distance between parallel planes when tested in accordance with Test Methods E8/E8M.

8.3 *Shapes*—Mechanical property requirements for shapes shall be subject to agreement between the manufacturer and the purchaser and the agreement shall be part of that contract or purchase order.

## 9. Dimensions, Mass, and Permissible Variations

9.1 The dimensions and tolerances for bar, rod and shapes produced under this specification shall be as specified in the following tables and paragraphs in Specification B249/B249M.

9.1.1 *Diameter or Distance Between Parallel Surfaces*:

9.1.1.1 *Rod in Length*—See Table 1.

9.1.1.2 *Bar, Rectangular and Square*—See Tables 8 and 10.

9.1.2 *Shapes*—Dimensional tolerances shall be subject to agreement between the manufacturer and the purchaser and the agreement shall be part of the contract or purchase order.



**B16/B16M – 19****TABLE 2 Tensile Requirements, inch-pound**NOTE 1—See **Table 3** for SI values.

Temper Designation Standard Name		Diameter or Distance Between Parallel Surfaces, in.		Tensile Strength, min, ksi	Yield Strength at 0.5 % Extension under Load, min, ksi	Elongation, <sup>A</sup> min, %
Rod and Wire						
O60	soft anneal	1 and under		48	20	15
		over 1 to 2, incl.		44	18	20
		over 2		40	15	25
H02	half-hard	under ½		57	25	7 <sup>B</sup>
		½ to 1, incl.		55 <sup>C</sup>	25	10
		over 1 to 2, incl.		50	20	15
		over 2 to 4, incl., and over 4		45	15	20
				40	15	20
H04	hard	⅛ to ⅜ incl.		80	45	
		over ⅜ to ½ incl.		70	35	4
		over ½ to ¾ incl.		65	30	6
Bar						
Standard Name		Thickness, in.	Width, in.			
O60	soft anneal	1 and under	6 and under	44	18	20
		over 1	6 and under	40	15	25
H02	half-hard	½ and under	1 and under	50	25	10
		½ and under	over 1 to 6, incl.	45	17	15
		over ½ to 2, incl.	2 and under	45	17	15
		over ½ to 2, incl.	over 2 to 6, incl.	40	15	20
		over 2	over 2 to 4, incl.	40	15	20

<sup>A</sup> In any case, a minimum gage length of 1 in. shall be used.<sup>B</sup> For product furnished in coils the elongation shall be 4 % min.<sup>C</sup> If product is specified for thread rolling applications, the minimum tensile strength shall be 52 ksi.**TABLE 3 Tensile Requirements, SI**NOTE 1—See **Table 2** for inch-pound values.

Temper Designation Standard Name		Diameter or Distance Between Parallel Surfaces, mm		Tensile Strength, min, MPa	Yield Strength at 0.5 % Extension under Load, min, MPa	Elongation, <sup>A</sup> min, %
Rod and Wire						
O60	soft anneal	25 and under		330	140	15
		over 25 to 50, incl.		305	125	20
		over 50		275	105	25
H02	half-hard	under 12		395	170	7 <sup>B</sup>
		12 to 25, incl.		380 <sup>C</sup>	170	10
		over 25 to 50, incl.		345	140	15
		over 50 to 100, incl., and over 100		310	105	20
				275	105	20
H04	hard	1.6 to 4, incl.		550	310	
		over 4 to 12, incl.		480	240	4
		over 12 to 18, incl.		450	205	6
Bar						
Standard Name		Thickness, mm		Width, mm		
O60	soft anneal	25 and under	150 and under	305	125	20
		over 25	150 and under	275	105	25
H02	half-hard	12 and under	25 and under	345	170	10
		12 and under	over 25 to 150, incl.	310	115	15
		over 12 to 50, incl.	50 and under	310	115	15
		over 12 to 50, incl.	over 50 to 150, incl.	275	105	20
		over 50	over 50 to 100, incl.	275	105	20

<sup>A</sup> In any case, a minimum gage length of 25 mm shall be used. SI elongation values are based on a gage length of 5.65 times the square root of the area for dimensions greater than 2.5 mm.<sup>B</sup> For product furnished in coils the elongation shall be 4 % min.<sup>C</sup> If product is specified for thread rolling applications, the minimum tensile strength shall be 350 MPa.



TABLE 4 Rockwell Hardness Requirements, inch-pound

NOTE 1—See Table 5 for SI values.

NOTE 2—Rockwell hardness requirements are not established for diameters less than 1/2 in.

Temper Designation		Diameter of Distance Between Parallel Surfaces, in.	Rockwell B Hardness Determined on the Cross Section Midway Between Surface and Center	
Rod and Wire				
Standard Name			Round	Hexagonal and Octagonal
O60	soft anneal	½ and over	10 to 45	10 to 45
H02	half-hard	½ to 1, incl.	60 to 80 <sup>A</sup>	55 to 80
		over 1 to 2, incl.	55 to 75	45 to 80
		over 2 to 3, incl.	45 to 70	40 to 65
		over 3 to 4, incl.	40 to 65	35 to 60
		over 4	25 min	25 min
Bar				
		Thickness, in.	Width, in.	
O60	soft anneal	½ and over	½ and over	10 to 35
H02	half-hard	½ and under	1 and under	45 to 85
		½ and under	over 1 to 6, incl.	35 to 70
		over ½ to 2, incl.	2 and under	40 to 80
			over 2 to 6, incl.	35 to 70
		over 2	over 2 to 4, incl.	35 to 70

<sup>A</sup> If product is specified for thread rolling application, the Rockwell B hardness shall be 55 to 75.

TABLE 5 Rockwell Hardness Requirements, SI

NOTE 1—See Table 4 for inch-pound values.

NOTE 2—Rockwell hardness requirements are not established for diameters less than 12 mm.

Temper Designation		Diameter of Distance Between Parallel Surfaces, mm	Rockwell B Hardness Determined on the Cross Section Midway Between Surface and Center	
Rod and Wire				
Standard Name			Round	Hexagonal and Octagonal
O60	soft anneal	12 and over	10 to 45	10 to 45
H02	half-hard	12 to 25, incl.	60 to 80 <sup>A</sup>	55 to 80
		over 25 to 50, incl.	55 to 75	45 to 80
		over 50 to 75, incl.	45 to 70	40 to 65
		over 75 to 100, incl.	40 to 65	35 to 60
		over 100	25 min	25 min
Bar				
		Thickness, mm	Width, mm	
O60	soft anneal	12 and over	12 and over	10 to 35
H02	half-hard	12 and under	25 and under	45 to 85
		12 and under	over 25 to 150, incl.	35 to 70
		over 12 to 50, incl.	50 and under	40 to 80
			over 50 to 150, incl.	35 to 70
		over 50	over 50 to 100, incl.	35 to 70

<sup>A</sup> If product is specified for thread rolling application, the Rockwell B hardness shall be 55 to 75.

## 9.1.3 Length:

9.1.3.1 Rod, Bar, and Shapes—See Tables 13 and 14.

9.1.4 Edge Contours—Refer to the subsection titled “Edge Contours” and Figs. 1, 2, and 3.

9.2 The dimensions and tolerances for wire product under this specification shall be as specified in Table 1 and the related section in Specification B250/B250M.

9.2.1 Wire, Coiled, Round—See Table 1.

## 10. Test Methods

## 10.1 Chemical Analysis:

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

Element	Test Method
Copper	E478
Lead	E478 atomic absorption
Iron	E478
Zinc	E478 titrimetric

10.2 Test method(s) to be followed for the determination of other element(s) resulting from contractual or purchaser order agreement shall be as agreed upon between the manufacturer and the purchaser.



**11. Purchases for U.S. Government Agencies**

11.1 Product purchased for agencies of the U.S. Government, when specified in the contract or purchase order, shall conform to the special Supplementary Requirements section in Specifications **B249/B249M** (rod, bar, and shapes) and **B250/B250M** (wire).

**12. Keywords**

12.1 Copper Alloy UNS No. C36000; Copper Alloy UNS No. C36010; free-cutting brass bar; free-cutting brass rod; free-cutting brass wire; screw machine rod

**SUMMARY OF CHANGES**

Committee B05 has identified the location of selected changes to this standard since the last issue (B16/B16M–10 (2015)) that may impact its use. (Approved Oct. 1, 2019.)

(1) Added adjustments to **Tables 2 and 3**.

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