



Standard Specification for Copper-Zinc-Tin and Copper-Zinc-Tin-Iron-Nickel Alloys Plate, Sheet, Strip, and Rolled Bar¹

This standard is issued under the fixed designation B 591; 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 covers the requirements for specified copper-zinc-tin alloys and copper-zinc-tin-iron-nickel alloys in the form of plate, sheet, strip, and rolled bar. The alloys and nominal compositions are as follows:

Copper Alloy UNS No. ²	Copper, %	Tin, %	Zinc, %	Phos., %%	Iron, %	Nickel, %
C40500	95	1	4			
C40810	95.5	2.0	2.22	0.03	0.1	0.15
C40850	95.5	3.0	1.27	0.03	0.1	0.1
C40860	94.8	2.0	3.04	0.03	0.03	0.1
C41100	91	0.5	8.5			
C41300	91	1	8			
C41500	91	2	7			
C42200	87	1	12			
C42500	88	2	10			
C42520	89.8	2.0	7.97	0.03	0.1	0.1
C43000	85	2	13			
C43400	85	0.7	14.3			

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 ASTM Standards:

B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar³

B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast³

B 846 Terminology for Copper and Copper Alloys³

E 8 Test Methods for Tension Testing of Metallic Materials⁴

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric)⁵

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys⁵

E 112 Test Methods for Determining the Average Grain Size⁴

E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition⁵

E 478 Test Methods for Chemical Analysis of Copper Alloys⁶

E 527 Practice for Numbering Metals and Alloys (UNS)⁷

3. Terminology

3.1 *Definitions*—For standard terms related to copper and copper alloys, refer to Terminology B 846.

4. General Requirements

4.1 The following sections of Specification B 248 constitute a part of this specification:

- 4.1.1 Terminology—Definitions,
- 4.1.2 Materials and Manufacturing,
- 4.1.3 Workmanship, Finish, and Appearance,
- 4.1.4 Sampling—except for chemical analysis,
- 4.1.5 Number of Tests and Retests,
- 4.1.6 Specimen Preparation,
- 4.1.7 Test Methods—except for chemical analysis,
- 4.1.8 Significance of Numerical Limits,
- 4.1.9 Inspection,
- 4.1.10 Rejection and Rehearing,
- 4.1.11 Certification,
- 4.1.12 Test Reports (Mill),
- 4.1.13 Packaging and Package Marking, and
- 4.1.14 Supplementary Requirements.

¹ This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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² New designations established in accordance with Practice E 527. In the new UNS system the designations for copper alloys are simply expansions of the present standard designations by a prefix “C” and a suffix “00.”

³ *Annual Book of ASTM Standards*, Vol 02.01.

⁴ *Annual Book of ASTM Standards*, Vol 03.01.

⁵ *Annual Book of ASTM Standards*, Vol 03.05.

⁶ *Annual Book of ASTM Standards*, Vol 03.06.

⁷ *Annual Book of ASTM Standards*, Vol 01.01.

4.2 In addition, when a section with a title identical to that referenced in 4.1 appears in this specification, it contains additional requirements, which supplement those appearing in Specification B 248.

5. Ordering Information

5.1 Contracts or purchase orders for product under this specification should include the following information:

5.1.1 ASTM designation and year of issue (for example, B 591-XX);

5.1.2 Copper Alloy UNS No. Designation (for example, C42500);

5.1.3 Temper (see Section 8);

5.1.4 Dimensions, that is, thickness, width, length, and so forth (see Section 12);

5.1.5 Form, that is, plate, sheet, strip, or rolled bar;

5.1.6 How furnished, that is, rolls, specific or stock lengths, with or without ends;

5.1.7 Quantity, that is, total weight each form, temper, and size; and

5.1.8 When material is purchased for agencies of the U.S. Government the requirements of Section 11 shall apply.

5.2 The following options are available under this specification and should be specified in the contract or purchase order when required:

5.2.1 Type of edge, that is, slit, sheared, sawed, square corners, round corners, rounded edges, or full rounded edges, and

5.2.2 Width and straightness tolerances (see Section 12).

6. Materials and Manufacture

6.1 *Material:*

6.1.1 The material of manufacture shall be Copper Alloy UNS No. C40500, C41100, C41300, C41500, C42200, C42000, C43300, C43400, C40810, C40850, C40860, or C42520 as specified in the ordering information.

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

NOTE 1—Because of 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.

6.2 *Manufacture:*

6.2.1 The product shall be manufactured by such hot working, cold working, and annealing processes as to produce a uniform wrought structure in the finished product.

6.2.2 The product shall be hot or cold worked to the finished size and subsequently annealed, when required, to meet the temper properties specified in the ordering information.

6.2.3 *Edges*—Slit edges shall be furnished unless otherwise specified in the contract or purchase order.

7. Chemical Composition

7.1 The material shall conform to the chemical compositional requirements specified in Table 1 for the copper alloy UNS No. designation specified in the ordering information.

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

7.2 Zinc, given as the “Remainder,” is the difference between the sum of the results for all elements determined and 100 %.

7.2.1 Copper may be determined by difference; however, when so determined, the results must conform to the requirements of Table 1.

7.3 When all elements specified in Table 1 for the designated alloy are determined, the sum of results shall equal at least 99.7 %.

8. Temper

8.1 *As Hot Rolled (M20) Material*—This standard temper of sheet and plate produced by hot rolling, where applicable, is shown in Table 2. (See Table 3 for SI equivalents.)

8.2 *H (Rolled Material)*—The standard tempers of rolled materials are as designated in Table 2 with the prefix “H.” Special tempers not listed in this specification are subject to agreement between the manufacturer and the purchaser.

8.3 *Annealed Material*—The standard tempers of annealed material are as designated in Table 4 in the column entitled “Nominal Grain Size.” Special tempers not listed in this specification are subject to agreement between the manufacturer and the purchaser.

8.4 Temper designations are defined in Practice B 601.

TABLE 1 Chemical Requirements

Copper Alloy UNS No.	Composition, %						
	Copper	Tin	Lead, max	Iron, max	Phosphorus, max	Nickel	Zinc
C40500	94.0-96.0	0.7-1.3	0.05	0.05	...	...	remainder
C40810	94.5-96.5	1.8-2.2	0.05	0.08-0.12	0.028-0.040	0.11-0.20	remainder
C40850	94.5-96.5	2.6-4.0	0.05	0.05-0.20	0.02-0.04	0.05-0.20	remainder
C40860	94.0-96.0	1.7-2.3	0.05	0.01-0.05	0.02-0.04	0.05-0.20	remainder
C41100	89.0-92.0	0.30-0.7	0.10	0.05	...	...	remainder
C41300	89.0-93.0	0.7-1.3	0.10	0.05	...	...	remainder
C41500	89.0-93.0	1.5-2.2	0.10	0.05	...	...	remainder
C42200	86.0-89.0	0.8-1.4	0.05	0.05	0.35	...	remainder
C42500	87.0-90.0	1.5-3.0	0.05	0.05	0.35	...	remainder
C42520	88.0-91.0	1.5-3.0	0.05	0.05-0.20	0.02-0.04	0.05-0.20	remainder
C43000	84.0-87.0	1.7-2.7	0.10	0.05	...	...	remainder
C43400	84.0-87.0	0.40-1.0	0.05	0.05	...	...	remainder



TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness Values for Rolled Tempers

NOTE 1—Plate is generally available in only the as hot-rolled (M20) temper. Required properties for other tempers shall be agreed upon between the manufacturer and the purchaser at the time of placing the order.

NOTE 2—See Table 3 for SI unit equivalents.

Temper Designation		Tensile Strength, ksi ^A		Approximate Rockwell Hardness			
				B-Scale		Superficial 30T	
Standard	Former	Min	Max	0.020 to 0.036 in. (0.51 to 0.91 mm), incl	Over 0.036 in. (0.91 mm)	0.012 to 0.028 in. (0.30 to 0.71 mm), incl	Over 0.028 in. (0.711 mm)
Copper Alloy UNS No. C40500							
M20	As hot-rolled	35	50	...	...	...	...
H01	Quarter hard	41	53	30-54	34-62	36-56	38-58
H02	Half hard	46	58	50-66	52-69	49-60	51-62
H03	Three-quarter hard	52	64	60-72	62-74	56-66	58-68
H04	Hard	58	70	66-76	68-78	60-68	62-70
H06	Extra hard	63	75	71-78	72-80	65-71	66-73
H08	Spring	68	80	75-81	76-83	67-72	68-74
H10	Extra spring	73	84	78-83	79-85	69-73	70-75
Copper Alloy UNS No. C40810							
H02	Half hard	57	73	65-80	66-81	60-70	62-72
H04	Hard	76	88	78-89	80-90	67-74	69-75
H06	Extra hard	90	100	82-90	83-92	69-75	70-76
H08	Spring	94	102	85-92	86-94	71-77	72-78
Copper Alloy UNS No. C40850							
H02	Half hard	57	73	65-80	67-81	60-69	62-72
H04	Hard	76	89	78-88	80-90	67-74	69-75
H06	Extra hard	90	100	82-91	83-93	69-75	70-76
H08	Spring	94	106	85-92	87-94	72-77	73-78
Copper Alloy UNS No. C40860							
H02	Half hard	56	72	64-80	65-80	60-70	61-72
H04	Hard	74	87	77-89	79-90	66-74	68-75
H06	Extra hard	88	98	81-90	82-91	68-75	69-76
H08	Spring	92	105	84-92	85-94	70-77	71-78
Copper Alloy UNS No. C41100							
M20	As hot-rolled	34	50	...	...	...	...
H01	Quarter hard	42	54	32-60	34-63	37-57	38-64
H02	Half hard	49	60	51-68	52-70	50-62	51-67
H03	Three-quarter hard	55	66	62-75	63-77	58-66	59-70
H04	Hard	61	72	68-79	69-81	62-70	64-71
H06	Extra hard	67	78	74-82	76-84	66-73	67-72
H08	Spring	73	83	78-84	77-86	69-74	70-73
H10	Extra spring	78	...	80 and over	80 and over	70 and over	71 and over
Copper Alloy UNS No. C41300							
M20	As hot-rolled	37	50	...	...	...	...
H01	Quarter hard	45	55	34-62	35-64	40-58	39-60
H02	Half hard	50	62	52-70	53-72	51-63	51-64
H03	Three-quarter hard	58	68	64-77	66-78	59-68	60-69
H04	Hard	65	75	71-80	72-81	63-70	64-70
H06	Extra hard	70	82	77-83	78-84	67-71	68-72
H08	Spring	76	86	81-86	82-87	70-73	70-74
H10	Extra spring	81	...	85 and over	86 and over	72 and over	73 and over
Copper Alloy UNS No. C41500							
M20	As hot rolled	38	50	...	...	...	...
H01	Quarter hard	46	56	48-73	49-75	48-65	49-67
H02	Half hard	53	63	68-78	70-80	62-68	63-70
H03	Three-quarter hard	57	68	73-80	75-82	65-70	66-71
H04	Hard	64	75	78-85	79-87	69-72	69-74
H06	Extra hard	70	82	81-87	82-90	70-73	70-75
H08	Spring	78	89	86-92	87-93	73-76	73-77
H10	Extra spring	85	...	89 and over	90 and over	74 and over	75 and over
Copper Alloy UNS No. C42200							
M20	As hot-rolled	40	53	...	...	...	...
H01	Quarter hard	47	57	42-68	44-70	43-62	46-65
H02	Half hard	54	65	64-74	66-76	58-68	61-70
H03	Three-quarter hard	60	72	71-80	73-82	64-69	66-71
H04	Hard	67	79	76-83	78-85	67-71	69-73
H06	Extra hard	75	85	80-85	82-87	69-73	70-74
H08	Spring	82	92	83-88	85-90	70-74	71-75

TABLE 2 *Continued*

Temper Designation		Tensile Strength, ksi ^A		Approximate Rockwell Hardness			
				B-Scale		Superficial 30T	
Standard	Former	Min	Max	0.020 to 0.036 in. (0.51 to 0.91 mm), incl	Over 0.036 in. (0.91 mm)	0.012 to 0.028 in. (0.30 to 0.71 mm), incl	Over 0.028 in. (0.711 mm)
H10	Extra spring	88	...	86 and over	86 and over	74 and over	74 and over
Copper Alloy UNS No. C42500							
M20	As hot-rolled	40	54	...	...	...	...
H01	Quarter hard	49	59	46-71	48-73	45-65	47-67
H02	Half hard	57	69	67-81	69-83	63-69	65-72
H03	Three-quarter hard	62	74	74-84	76-86	66-71	68-73
H04	Hard	70	82	81-88	83-90	70-74	72-76
H06	Extra hard	76	88	86-92	88-94	71-75	73-77
H08	Spring	84	94	89-93	91-95	73-77	74-78
H10	Extra spring	92	...	92 and over	92 and over	76 and over	77 and over
Copper Alloy UNS No. C42520							
H02	Half hard	67	82	68-83	70-85	64-71	67-73
H04	Hard	81	96	82-90	83-92	71-76	72-78
H06	Extra hard	92	107	85-94	87-96	72-77	73-79
H08	Spring	97	112	88-96	90-98	74-79	75-81
H10	Extra spring	103	118	91-101	92-102	76-82	77-83
Copper Alloy UNS No. C43000							
M20	As hot-rolled	40	55	...	...	...	...
H01	Quarter hard	47	60	41-68	45-72	47-64	50-67
H02	Half hard	55	69	64-79	67-82	58-70	60-72
H03	Three-quarter hard	65	78	72-83	75-86	64-72	66-74
H04	Hard	72	84	78-87	80-89	68-75	70-77
H06	Extra hard	83	93	83-89	85-91	70-77	72-79
H08	Spring	89	98	87-92	89-94	74-79	75-80
H10	Extra spring	90	...	89 and over	91 and over	75 and over	76 and over
Copper Alloy UNS No. C43400							
M20	As hot-rolled	37	50	...	...	...	...
H01	Quarter hard	45	58	39-64	43-68	45-61	48-64
H02	Half hard	52	66	55-74	58-77	56-68	58-70
H03	Three-quarter hard	61	74	65-77	68-80	64-70	64-72
H04	Hard	68	80	73-84	75-86	65-74	67-76
H06	Extra hard	78	89	76-87	78-89	69-76	71-78
H08	Spring	85	94	81-89	83-91	73 and over	74-79
H10	Extra spring	88	...	83 and over	85 and over	74 and over	75 and over

^Aksi = 1000 psi.

TABLE 3 Tensile Strength Conversion Values for Table 2

ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
41	[283]	61	[424]	79	[545]	94	[648]
42	[290]	62	[427]	80	[552]	95	[655]
44	[303]	63	[434]	81	[558]	96	[662]
45	[310]	64	[441]	82	[565]	97	[669]
46	[317]	65	[448]	83	[572]	98	[676]
47	[324]	66	[455]	84	[579]	99	[683]
49	[338]	67	[462]	85	[586]	100	[689]
50	[345]	68	[469]	86	[593]	102	[703]
52	[359]	69	[476]	87	[600]	103	[710]
53	[365]	70	[483]	88	[607]	105	[723]
54	[372]	72	[496]	89	[614]	106	[730]
56	[386]	73	[503]	90	[621]	107	[737]
57	[393]	74	[510]	91	[627]	112	[772]
58	[400]	75	[517]	92	[634]	118	[813]
59	[407]	76	[524]	93	[641]		
60	[414]	78	[538]				

9. Grain Size for Annealed Tempers

9.1 Grain size shall be the standard requirement for all products in the annealed tempers.

9.2 Acceptance or rejection based upon grain size shall depend only on the average grain size of test specimen taken

TABLE 4 Grain Size Requirements for Annealed Material

Copper Alloy UNS No.	Temper Designation	Average Grain Size, mm		
		Nominal	Min	Max
C40500, C40810,	OS035	0.035	0.025	0.050
C40850, C40860,	OS025	0.025	0.015	0.035
C41100, C41300,	OS015	0.015	^A	0.025
C41500, C42200,				
C42500, C42520,				
C43000, and C43400				

^AAlthough no minimum grain size is required, this material shall be fully recrystallized.

from each of two sampling portions and each specimen shall be within the limits prescribed in Table 4 when determined in accordance with Test Methods E 112.

9.3 Grain size shall be determined on a plane parallel to the flat surfaces of the product.

10. Mechanical Property Requirements

10.1 Tensile Strength Requirements:

10.1.1 Product in “H” (rolled) tempers shall conform to the requirements prescribed in Table 2 for the temper and UNS

Alloy Number specified in the ordering information when tested in accordance with Test Methods E 8.

10.1.2 Test specimens shall be taken so that the longitudinal axis is parallel to the direction of rolling.

10.2 *Rockwell Hardness Requirements*—The approximate Rockwell values given in Table 2 and Table 5 are given for general information and assistance in testing and shall not be used as a basis for rejection.

NOTE 2—The Rockwell hardness test offers a quick and convenient method of checking for general conformity to the specification requirements for temper, tensile strength, and grain size.

11. Other Requirements

11.1 *Purchases for U.S. Government Agencies*—When identified in the contract or purchase order, product purchased for agencies of the U.S. Government shall conform to the special government-stipulated requirements in the supplemental requirements given in Specification B 248.

12. Dimensions, Mass, and Permissible Variations

12.1 The dimensions and tolerances for product described by this specification shall be as specified in Specification B 248, with particular reference to the following tables and related paragraphs in that specification:

TABLE 5 Approximate Rockwell Hardness of Annealed Material

Temper Designation	Annealed Temper Nominal Grain Size	Approximate Rockwell Hardness ^A	
		F Scale	Superficial 30T
OS035	0.035	51-60	2-16
OS025	0.025	55-61	8-18
OS015	0.015	60-75	16-37
Copper Alloy UNS No. C41100			
OS035	0.035	57-63	15-26
OS025	0.025	62-69	21-32
OS015	0.015	63-75	26-37
Copper Alloy UNS No. C41300			
OS035	0.035	58-66	17-27
OS025	0.025	63-72	22-33
OS015	0.015	66-79	27-42
Copper Alloy UNS No. C41500			
OS035	0.035	61-67	20-28
OS025	0.025	63-73	22-35
OS015	0.015	67-81	28-44
Copper Alloy UNS No. C42200			
OS035	0.035	62-68	24-29
OS025	0.025	65-74	26-36
OS015	0.015	68-86	29-61
Copper Alloy UNS No. C42500			
OS035	0.035	67-73	28-35
OS025	0.025	69-75	30-42
OS015	0.015	73-90	35-55
Copper Alloy UNS No. C43000			
OS035	0.035	63-74	20-39
OS025	0.025	65-79	25-42
OS015	0.015	68-85	28-50
Copper Alloy UNS No. C43400			
OS035	0.035	59-69	19-24
OS025	0.025	60-70	20-32
OS015	0.015	63-76	20-39

^ARockwell hardness values apply as follows: The F scale applies to metal 0.020 in. (0.5 mm) in thickness and over; the 30T scale applies to metal 0.015 in. (0.38 mm) in thickness and over.

12.1.1 *Thickness*—Tolerances as in Table 1.

12.1.2 *Width*:

12.1.2.1 Tolerances for slit metal and slit metal with rolled edges as in Table 4.

12.1.2.2 Tolerances for square-sheared metal as in Table 5.

12.1.2.3 Tolerances for sawed metal as in Table 6.

12.1.3 *Length*:

12.1.3.1 Tolerances for straight lengths as in Table 7.

12.1.3.2 Schedule of minimum lengths with ends as in Table 8.

12.1.3.3 Tolerances for squared-sheared metal as in Table 9.

12.1.3.4 Tolerances for sawed metal as in Table 10.

12.1.4 *Straightness*:

12.1.4.1 Tolerances for slit metal or slit metal either straightened or edge rolled as in Table 11.

12.1.4.2 Tolerances for squared-sheared metal as in Table 12.

12.1.4.3 Tolerance for squared-sheared metal as in Table 13.

12.1.5 *Edges*:

12.1.5.1 Tolerances for radius of square edges as in Table 14.

12.1.5.2 Tolerances for radius of round corners as in Table 15.

12.1.5.3 Tolerances for radius of round edges as in Table 16.

12.1.5.4 Tolerances for radius of full rounded edges as in Table 17.

13. Sampling

13.1 *Chemical Analysis*:

13.1.1 The sample for chemical analysis shall be taken from the pieces selected and combined into one composite sample in accordance with Practice E 255 for product in its final form. The minimum weight of the composite sample shall be 150 g.

13.1.2 Instead of sampling in accordance with Practice E 255, the manufacturer shall have the option of taking samples at the time the castings are poured or by taking samples from the semi-finished product.

13.1.2.1 When composition of the material has been determined during the course of manufacture, sampling of the finished product by the manufacturer is not required.

13.1.3 The number of samples to be taken for determination of chemical composition shall be as follows:

13.1.3.1 When sampled at the time the castings are poured, at least one sample shall be taken for each group of castings poured from the same source of molten metal.

13.1.3.2 When sampled from the semi-finished product, at least one sample shall be taken to represent each 10 000 lb or fraction thereof, except that not more than one sample shall be required per piece.

13.1.3.3 Only one sample needs to be taken from the semi-finished product of one cast bar from a single furnace melt charge continuously processed.

14. Test Methods

14.1 Chemical Analysis:

14.1.1 Chemical composition shall be determined, in case of disagreement, by the following appropriate method:

Element	Test Method
Copper	E 478
Iron	E 76 (AA)
Lead	E 478 (AA)
Nickel	E 478 (Photometric)
Phosphorus	E 62
Tin	E 478 (Photometric)
Zinc	E 478 (AA)

14.1.2 Test methods(s) used for the determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the manufacturer and the purchaser.

15. Keywords

15.1 copper-zinc-tin alloy plate; copper-zinc-tin alloy rolled bar; copper-zinc-tin alloy sheet; copper-zinc-tin alloy strip; copper-zinc-tin-iron-nickel alloy plate; copper-zinc-tin-iron-nickel alloy rolled bar; copper-zinc-tin-iron-nickel alloy sheet; copper-zinc-tin-iron-nickel alloy strip

SUMMARY OF CHANGES

Committee B05 has identified the location of selected changes to this standard since the last issue, B 591-98, that may impact the use of this standard.

- (1) Title has been changed to include copper-zinc-tin-iron-nickel alloys.
- (2) Added to the Scope, Section 1.
- (3) Added to 6.1.1.
- (4) Added to Table 1.
- (5) Added to 8.1.

- (6) Added to Table 2.
- (7) Added to Table 3.
- (8) Added to Table 4.
- (9) Added to 14.1.1.
- (10) Added to Keywords, Section 15.

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