



**Designation: B103/B103M-09** ~~Designation: B103/B103M - 10~~

## Standard Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar<sup>1</sup>

This standard is issued under the fixed designation B103/B103M; 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 copper-tin alloy (phosphor bronze), copper-tin-lead alloy (leaded phosphor bronze), and copper-tin-lead-zinc alloy (bearing bronze), plate, sheet, strip, and rolled bar. The phosphor bronzes commonly are used for deep drawing into bellows and stamping and forming into spring devices and into terminals and connectors for electrical apparatus because they combine high strength with high elongation. The leaded phosphor bronzes are used where strength, corrosion resistance, and machinability are required. The bearing bronze is used in bushings, bearings, and load-bearing thrust washers. The following alloys are covered:

| Copper Alloy<br>UNS No. <sup>2</sup> | Copper | Nominal Composition, % |      |      | Previously Used<br>Designation |
|--------------------------------------|--------|------------------------|------|------|--------------------------------|
|                                      |        | Tin                    | Zinc | Lead |                                |
| C51000                               | 95     | 5                      | ...  | ...  | A1                             |
| C51100                               | 96     | 4                      | ...  | ...  | A                              |
| C51180                               | 96     | 4                      | ...  | ...  | ...                            |
| C51900                               | 94     | 6                      | ...  | ...  | ...                            |
| C52100 <sup>A</sup>                  | 92     | 8                      | ...  | ...  | C                              |
| C52180                               | 92     | 8                      | ...  | ...  | ...                            |
| C52400                               | 90     | 10                     | ...  | ...  | D                              |
| C53400                               | 94     | 5                      | ...  | 1    | B1                             |
| C54400                               | 88     | 4                      | 4    | 4    | B2                             |

<sup>A</sup> SAE Specification CA 521 conforms to the requirements of UNS No. C52100.

NOTE 1—All of the above alloys contain small amounts of phosphorus, used as a deoxidant in melting, and to enhance the mechanical properties.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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:<sup>3</sup>

- B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar
- B248M Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar (Metric)
- B601 Classification for Temper Designations for Copper and Copper Alloys Wrought and Cast
- B846 Terminology for Copper and Copper Alloys
- E8 Test Methods for Tension Testing of Metallic Materials
- E8M Test Methods for Tension Testing of Metallic Materials [Metric]
- E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes
- E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)
- E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys
- E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

<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 B05.01 on Plate, Sheet, and Strip.

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<sup>2</sup> The UNS system for copper and copper alloys (see Practice E527) is a simple expansion of the former standard designation system accomplished by the addition of a prefix "C" and a suffix "00." The suffix can be used to accommodate composition variations of the base alloy.

<sup>3</sup> 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.

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

E478 Test Methods for Chemical Analysis of Copper Alloys

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

### 3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology B846.

### 4. Ordering Information

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

4.1.1 ASTM designation and year of issue (for example, B103/B103M – 04);

4.1.2 Copper Alloy UNS No. designation (for example, C51000);

4.1.3 Temper (Section 8);

4.1.4 Dimensions: thickness, width, length, and so forth (Section 12);

4.1.5 Form: plate, sheet, strip, or rolled bar;

4.1.6 How furnished: coils, specific length or stock lengths, with or without ends;

4.1.7 Quantity: total weight each form, temper, and size; and,

4.1.8 When material is purchased for agencies of the U.S. Government (Section 11).

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

4.2.1 Type of edge: slit, sheared, sawed, square corners, round corners, rounded edges, or full rounded edges;

4.2.2 Width and straightness tolerances (Section 12);

4.2.3 Heat identification or traceability details;

4.2.4 Certification, and

4.2.5 Mill test report.

### 5. General Requirements

5.1 The following sections of Specification B248 constitute a part of this specification.

5.1.1 Terminology,

5.1.2 Materials and Manufacturing,

5.1.3 Workmanship, Finish, and Appearance,

5.1.4 Sampling, Except for Chemical Analysis,

5.1.5 Number of Tests and Retests,

5.1.6 Specimen Preparation,

5.1.7 Test Methods, Except for Chemical Analysis,

5.1.8 Significance of Numerical Limits,

5.1.9 Inspection,

5.1.10 Rejection and Rehearing, [g/standards/sist/c9b496d6-76b3-4313-aa1a-bc4966f8a1cf/astm-b103-b103m-10](https://standards.iteh.ai/standards/sist/c9b496d6-76b3-4313-aa1a-bc4966f8a1cf/astm-b103-b103m-10)

5.1.11 Certification,

5.1.12 Test Reports (Mill),

5.1.13 Packaging and Package Marking, and

5.1.14 Supplementary Requirements.

5.2 In addition, when a section with a title identical to that referenced in 5.1, appears in this specification, it contains additional requirements, which supplement those appearing in Specification B248.

### 6. Materials and Manufacture

6.1 *Materials*:

6.1.1 The material of manufacture shall be a cast bar, cake, slab, or Copper Alloy UNS No. C51000, C51100, C51180, C51900, C52100, C52180, C52400, C53400, or C54400 as specified in the ordering information.

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

NOTE 2—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.

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

### 7. Chemical Composition

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

**TABLE 1 Chemical Requirements**

| Element    | Composition, %       |           |           |           |           |           |           |                     |                     |
|------------|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|---------------------|---------------------|
|            | Copper Alloy UNS No. |           |           |           |           |           |           |                     |                     |
|            | C51000               | C51100    | C51180    | C51900    | C52100    | C52180    | C52400    | C53400 <sup>A</sup> | C54400 <sup>A</sup> |
| Tin        | 4.2-5.8              | 3.5-4.9   | 3.5-4.9   | 5.0-7.0   | 7.0-9.0   | 7.0-9.0   | 9.0-11.0  | 3.5-5.8             | 3.5-4.5             |
| Phosphorus | 0.03-0.35            | 0.03-0.35 | 0.01-0.35 | 0.03-0.35 | 0.03-0.35 | 0.01-0.35 | 0.03-0.35 | 0.03-0.35           | 0.01-0.50           |
| Iron, max  | 0.10                 | 0.10      | 0.05-0.20 | 0.10      | 0.10      | 0.05-0.20 | 0.10      | 0.10                | 0.10                |
| Lead       | 0.05 max             | 0.05 max  | 0.05 max  | 0.05 max  | 0.05 max  | 0.05 max  | 0.05 max  | 0.8-1.2             | 3.0-4.0             |
| Zinc       | 0.30 max             | 0.30 max  | 0.30 max  | 0.30 max  | 0.20 max  | 0.30 max  | 0.20 max  | 0.30 max            | 1.5-4.5             |
| Nickel     | ...                  | ...       | 0.05-0.20 | ...       | ...       | 0.05-0.20 | ...       | ...                 | ...                 |
| Copper     | remainder            | remainder | remainder | remainder | remainder | remainder | remainder | remainder           | remainder           |

<sup>A</sup> When specified for bearings, the phosphorus content shall be maintained from 0.01 to 0.15 %.

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

7.3 Copper, specified as the “remainder,” may be taken as the difference between the sum of all the elements analyzed and 100 %. When all the elements in Table 1 are analyzed, the sum of results for each alloy shall be 99.5 % min.

## 8. Temper

8.1 *M20 (as Hot-Rolled Material)*—The standard temper of sheet and plate produced by hot rolling and is as designated in Table 2.

8.2 *H (Rolled Material)*—The standard tempers of rolled material are as designated in Table 2 with prefix “H.” Former designations and the standard designations as defined in Classification B601 are shown.

NOTE 3—The properties of special and nonstandard tempers are subject to agreement between the manufacture and purchaser.

8.3 *O60 (Annealed)*—The standard temper is O60 (soft), as indicated in Table 2.

## 9. Grain Size of Annealed Tempers

9.1 Other than O60 (soft) temper, as indicated in Table 2, annealed tempers are special, and the material shall conform to grain size requirements agreed upon between manufacturer and purchaser as defined in Classification B601.

## 10. Mechanical Property Requirements

### 10.1 Tensile Strength Requirements :

10.1.1 Products ordered to this specification in inch-pound units shall be tested in accordance with Test Methods E8 and shall conform to tensile strength requirements prescribed in ksi units in Table 2.

10.1.2 Products ordered to this specification in SI units shall be tested in accordance with Test Methods E8M, and shall conform to tensile strength requirements prescribed in MPa units in Table 2.

10.1.3 Acceptance or rejection based on mechanical properties shall depend only on the tensile strength.

10.1.4 The tension test specimens shall be taken so the longitudinal axis of the specimens is parallel to direction of rolling.

### 10.2 Rockwell Hardness:

10.2.1 The approximate Rockwell hardness values given in Table 2 are for general information and assistance in testing and shall not be used as a basis for product rejection.

NOTE 4—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 requirements stipulated in the supplemental requirements given in Specification B248.

## 12. Dimensions, Mass, and Permissible Variations

12.1 The dimensions and tolerances for product described by this specification shall be as specified in Specification B248 with particular reference to the following tables and related paragraphs in that specification.

### 12.1.1 Thickness:

12.1.1.1 *Tolerances*—See Table 1.

### 12.1.2 Width:

12.1.2.1 *Tolerances for Slit Metal and Slit Metal with Rolled Edges*—See Table 4.

12.1.2.2 *Tolerances for Square-Sheared Metal*—See Table 5.

12.1.2.3 *Tolerances for Sawed Metal*—See Table 6.

**TABLE 2 Tensile Strength Requirements and Approximate Rockwell Hardness Values**

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 purchaser at the time of placing the order.

| Temper Designation <sup>A</sup>                  |                          | Thickness, in. [mm]                      | Tensile Strength, ksi <sup>B</sup><br>[MPa] |                      | Approximate Rockwell Hardness |                  |
|--|--------------------------|--|---|----------------------|-------------------------------|------------------|
| Standard   | Former                   |  | Min   | Max                  | B Scale                       | Superficial 30–T |
| Copper Alloy UNS No. C51000                      |                          |  |   |                      |                               |                  |
| M20  | as hot-rolled            | Over 0.188 [4.775]                       | 40 [275]                                    | 60 [415]             | ...                           | ...              |
| O60  | soft                     | Over 0.039 [0.991]                       | 43 [295]                                    | 58 [400]             | 16-64                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 32-59            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 12-60                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 24-53            |
|  |                          | 0.003 [0.076] to 0.010 [0.254] incl      |   |                      |                               |                  |
| H02  | half-hard                | Over 0.039 [0.991]                       | 58 [400]                                    | 73 [505]             | 64-85                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 59-73            |
|  |                          | Over 0.02 [0.508] to 0.039 [0.991] incl  |   |                      | 60-82                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 53-69            |
|  |                          | 0.003 [0.076] to 0.010 [0.254] incl      |   |                      |                               |                  |
| H04  | hard                     | Over 0.039 [0.991]                       | 76 [525]                                    | 91 [625]             | 86-93                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 73-78            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 84-91                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 71-75            |
|  |                          | 0.003 [0.076] to 0.010 [0.254] incl      |   |                      |                               |                  |
| <del>H06</del>                                   | <del>extra-hard</del>    | <del>Over 0.039 [0.991]</del>            | <del>88 [606]</del>                         | <del>103 [710]</del> | <del>92-96</del>              | <del>...</del>   |
| H06  | extra-hard               | Over 0.039 [0.991]                       | 88 [605]                                    | 103 [710]            | 92-96                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 77-81            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 89-95                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 74-78            |
|  |                          | 0.003 [0.076] to 0.010 [0.254] incl      |   |                      |                               |                  |
|  |                          |  |   |                      |                               |                  |
| H08  | spring                   | Over 0.039 [0.991]                       | 95 [655]                                    | 110 [760]            | 94-98                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 79-82            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 92-97                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 76-80            |
|  |                          | 0.003 [0.076] to 0.010 [0.254] incl      |   |                      |                               |                  |
| <del>H10</del>                                   | <del>extra-spring</del>  | <del>Over 0.039 [0.991]</del>            | <del>100 [690]</del>                        | <del>114 [790]</del> | <del>96-99</del>              | <del>...</del>   |
| H10  | extra-spring             | Over 0.039 [0.991]                       | 100 [690]                                   | 114 [785]            | 96-99                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 80-83            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 94-98                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 77-81            |
|  |                          | 0.003 [0.076] to 0.010 [0.254] incl      |   |                      |                               |                  |
|  |                          |  |   |                      |                               |                  |
| Copper Alloy UNS Nos. C51100, C53400, and C54400 |                          |  |   |                      |                               |                  |
| <del>M20</del>                                   | <del>as hot-rolled</del> | <del>Over 0.188 [4.775]</del>            | <del>40 [275]</del>                         | <del>58 [415]</del>  | <del>...</del>                | <del>...</del>   |
| M20  | as hot-rolled            | Over 0.188 [4.775]                       | 40 [275]                                    | 58 [400]             | ...                           | ...              |
| O60  | soft                     | Over 0.039 [0.991]                       | 40 [275]                                    | 55 [380]             | 7-50                          | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 24-50            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 0-45                          | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 16-46            |
|  |                          |  |   |                      |                               |                  |
| <del>H02</del>                                   | <del>half-hard</del>     | <del>Over 0.039 [0.991]</del>            | <del>55 [380]</del>                         | <del>70 [485]</del>  | <del>60-81</del>              | <del>...</del>   |
| H02  | half-hard                | Over 0.039 [0.991]                       | 55 [380]                                    | 70 [485]             | 60-81                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 57-73            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 53-78                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 52-71            |
|  |                          |  |   |                      |                               |                  |
|  |                          |  |   |                      |                               |                  |
| <del>H04</del>                                   | <del>hard</del>          | <del>Over 0.039 [0.991]</del>            | <del>72 [496]</del>                         | <del>87 [600]</del>  | <del>82-90</del>              | <del>...</del>   |
| H04  | hard                     | Over 0.039 [0.991]                       | 72 [495]                                    | 87 [600]             | 82-90                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 71-77            |
|  |                          | Over 0.020 [0.506] to 0.039 [0.991] incl |   |                      | 80-86                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 69-75            |
|  |                          |  |   |                      |                               |                  |
|  |                          |  |   |                      |                               |                  |
| H06  | extra-hard               | Over 0.039 [0.991]                       | 84 [580]                                    | 99 [685]             | 88-94                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 75-80            |
|  |                          | Over 0.020 [0.506] to 0.039 [0.991] incl |   |                      | 86-92                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 73-78            |
|  |                          |  |   |                      |                               |                  |
| <del>H08</del>                                   | <del>spring</del>        | <del>Over 0.039 [0.991]</del>            | <del>91 [625]</del>                         | <del>106 [720]</del> | <del>90-98</del>              | <del>...</del>   |
| H08  | spring                   | Over 0.039 [0.991]                       | 91 [625]                                    | 106 [725]            | 90-98                         | ...              |
|  |                          | Over 0.029 [0.737]                       |   |                      | ...                           | 77-81            |
|  |                          | Over 0.020 [0.508] to 0.039 [0.991] incl |   |                      | 86-94                         | ...              |
|  |                          | Over 0.010 [0.254] to 0.029 [0.737] incl |   |                      | ...                           | 75-79            |
|  |                          |  |   |                      |                               |                  |
|  |                          |  |   |                      |                               |                  |
| <del>H10</del>                                   | <del>extra-spring</del>  | <del>Over 0.039 [0.991]</del>            | <del>96 [680]</del>                         | <del>108 [750]</del> | <del>92-97</del>              | <del>...</del>   |
| H10  | extra-spring             | Over 0.039 [0.991]                       | 96 [660]                                    | 108 [750]            | 92-97                         | ...              |