



Designation: B398/B398M – 22

# Standard Specification for Aluminum-Alloy 6201-T81 and 6201-T83 Wire for Electrical Purposes<sup>1</sup>

This standard is issued under the fixed designation B398/B398M; 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.

## 1. Scope

1.1 This specification covers aluminum-alloy 6201-T81 (hard, solution heat-treated, cold worked, and artificially aged) and 6201-T83 (hard, higher conductivity, solution heat-treated, cold worked, and artificially aged) round wire for electrical purposes.

NOTE 1—The alloy and temper designations conform to ANSI H35.1 and H35.1M. Aluminum-alloy 6201 corresponds to unified numbering system alloy A96201 in accordance with Practice E527.

1.2 The values stated in inch-pound or SI units are to be regarded separately as standard. The values 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 the specification.

1.2.1 For density, resistivity and temperature, the values stated in SI units are to be regarded as standard.

1.3 *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 The following documents of this issue in effect on date of material purchase form a part of this specification to the extent referenced herein.

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

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

[B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products](#)

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.07 on Conductors of Light Metals.

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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.

[B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products \(Metric\)](#)

[B830 Specification for Uniform Test Methods and Frequency](#)

[E527 Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

2.3 *ANSI Standard:*<sup>3</sup>

[ANSI H35.1 American National Standard for Alloy and Temper Designation Systems for Aluminum](#)

[ANSI H35.1M American National Standard Alloy and Temper Designation Systems for Aluminum \[Metric\]](#)

2.4 *NIST Standard:*<sup>4</sup>

[NBS Handbook 100—Copper Wire Tables](#)

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—a group of production units, up to 30 000 lb [15 metric tons] of mass, of one type and size of wire, which was produced during the same time period, under similar production conditions, and is presented for acceptance at the same time (Explanatory [Notes 1 and 2](#)).

3.1.2 *production unit*—a coil, reel, spool, or other package of wire that represents a single usable length.

3.1.3 *sample*—the production unit or units from which a test specimen or specimens has been removed, and which is considered to have properties representative of the lot.

3.1.4 *specimen*—a length of wire removed for test purposes.

## 4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Quantity of each size,

4.1.2 Wire size: diameter in inches or in millimetres (see [1.1](#)),

4.1.3 Special tension test, if required (see [7.2](#) and [7.3](#)),

4.1.4 Frequency of bending test (see [8.2](#)),

4.1.5 Special jointing procedures, if permitted (see [12.2](#)),

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>4</sup> Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, <http://www.ntis.gov>.

- 4.1.6 Place of inspection (see 15.2),
- 4.1.7 Package size and type (see 16.1), and
- 4.1.8 Special package marking, if required (see 16.4).

## 5. Material and Manufacture

5.1 The aluminum alloy used shall be of such quality that wire produced from it can comply with the requirements as to chemical composition, tensile and elongation properties, bending properties, and electrical resistivity prescribed in this specification.

## 6. Chemical Composition

6.1 The wire shall be made from aluminum alloy 6201 as designated in ANSI H35.1 and H35.1M. The material shall conform to the chemical composition prescribed in **Table 1**.

## 7. Tensile Properties

7.1 The heat-treated, drawn, and artificially aged wire when sampled in accordance with Section 14 of this specification and tested in accordance with Test Methods B557 and B557M for 6201-T81 shall conform to the tensile requirements prescribed in **Table 2** and for 6201-T83 to the tensile requirements of **Table 3** (Explanatory Note 3).

7.2 When requested by the purchaser, tension tests shall be made on specimens of heat-treated, drawn, and artificially aged wire containing joints made in the wire after heat treatment and prior to final drawing. Such tests shall show not less than 90 % of the minimum strength specified in **Table 2** (for 6201-T81) or **Table 3** (for 6201-T83) for individual test.

7.3 When requested by the purchaser, tension tests shall be made on specimens of heat-treated, drawn, and artificially aged wire containing joints made in the finished wire or during the final drawing as permitted in 12.2. Such tests shall show the tensile strength to be not less than 42 ksi (290 MPa) (for 6201-T81) or 32 ksi (220 MPa) (for 6201-T83) for cold-pressure welds and for electric-butt, cold-upset welds and not less than 15 ksi (100 MPa) for electric-butt welds. Electric-butt welds in addition shall show a minimum elongation of 6 % in 10 in. [250 mm].

**TABLE 1 Chemical Requirements<sup>A</sup>**

Element	Composition, %
Copper, max	0.10
Iron, max	0.50
Silicon	0.50–0.9
Manganese, max	0.03
Magnesium	0.6–0.9
Zinc, max	0.10
Chromium, max	0.03
Boron, max	0.06
Other elements, each, max	0.03
Other elements, total, max	0.10
Aluminum	remainder

<sup>A</sup> Analysis shall regularly be made only for the elements specified in this table. If, however, the presence of other elements is suspected or indicated in amounts greater than the specified limits, further analysis shall be made to determine that these elements are not present in amounts in excess of the specified limits for other elements.

**TABLE 2 Tensile Requirements (6201-T81)**

Diameter, in. [mm]	Tensile Strength, min	Elongation in 10 in. [250 mm] for Individual Tests, min, %
Over 0.1280 [3.25]	Through 0.1878 [4.75]	46 (315) 44 (305) 3.0
0.0610 [1.50]	0.1280 [3.25]	48 (330) 46 (315) 3.0

**TABLE 3 Tensile Requirements (6201-T83)**

Diameter, in. [mm]	Tensile Strength, min	Elongation in 10 in. [250 mm] for Individual Tests, min, %
Over 0.0610 [1.50]	Through 0.1878 [4.75]	36 (250) 34 (235) 3.5

**TABLE 4 Equivalent Resistivity Values at 20 °C [68 °F]<sup>A</sup>**

Material	Volume Conductivity % IACS	Resistivity Constants <sup>A</sup>
		Volume
Copper	100	10.371 [0.017241]
Aluminum	61.0	17.002 [0.028265]
	57.5	18.036 [0.029984]
	53.5	19.385 [0.032227]
	52.5	19.755 [0.032841]

<sup>A</sup> The equivalent resistivity values for 100 % IACS (soft copper) were each computed from the fundamental IEC value [ $1/58 \Omega \cdot \text{mm}^2/\text{m}$ ] using conversion factors each accurate to at least seven significant figures. Corresponding values for other conductivities (aluminum) were derived from these by multiplying by the reciprocal of the conductivity ratios accurate to at least seven significant figures.

## 8. Bending Properties

8.1 The wire shall be free of brittleness as evidenced by its ability to be wrapped at least six times around its own diameter, with or without a mandrel (see 14.3). The edge-to-edge spacing of consecutive turns shall not exceed two times the diameter of the wire. No fracture shall occur. Slight surface checks shall not constitute cause for rejection.

8.2 Any coil or reel may be tested in accordance with 8.1, but the frequency of production sampling and testing shall be by agreement between the manufacturer and the purchaser.

## 9. Resistivity

9.1 Electrical resistivity, determined on samples selected in accordance with Section 14 of this specification and tested in accordance with Test Method B193, shall not exceed 0.032841  $\Omega \cdot \text{mm}^2/\text{m}$  at 20 °C [68 °F] (for 6201-T81) and shall not exceed 0.029984  $\Omega \cdot \text{mm}^2/\text{m}$  at 20 °C [68 °F] (for 6201-T83) (Explanatory Note 2 and Table 4).

## 10. Density

10.1 For the purpose of calculating mass, mass per unit length, mass cross sections, etc., the density of aluminum-alloy 6201 shall be taken as 2690  $\text{kg}/\text{m}^3$  (0.097  $\text{lb}/\text{in.}^3$ ) at 20 °C.

## 11. Diameter and Permissible Variations

11.1 The diameter of the wire shall be expressed in decimal fractions of an inch using four places of decimals or in millimetres using two places of decimals.



11.2 Ten percent, but not less than five coils or spools (or all if the lot is less than five) from any lot of wire shall be gauged at three places. If the material is in coil form, one gauging shall be made near each end and one near the middle.

11.3 The permissible variations in diameter are as follows:

Specified Diameter, in. [mm]	Permissible Variations of Mean Diameter from Specified Diameter, plus and minus
0.1878 to 0.1000 [4.75 to 2.55], incl	1 %
Under 0.1000 to 0.0612 [2.55 to 1.50], incl	0.0010 in. [0.03 mm]

12. Joints

12.1 Unless otherwise specified at the time of placing the order, wire shall be supplied in one continuous length of reel, coil, or spool. Joints may be made in the drawing stock or wire after heat treatment and prior to final drawing by electric-butt welding, by cold-pressure welding, or by electric-butt, cold-upset welding in accordance with good commercial practice. Unless otherwise specified, no joints shall be made during final drawing or in the finished wire.

12.2 If agreed upon between the manufacturer and the purchaser, joints may be made during final drawing or in the finished wire by cold-pressure welding, by electric-butt, cold-upset welding, or by electric-butt welding. Following welding, electric-butt welds shall be annealed for a distance of at least 6 in. [150 mm] on each side of the weld. Not more than 10 % of the reels, coils, or spools shall contain such joints and no joint shall be closer than 50 ft [15 m] to another or to either end of the wire, and not more than two such joints shall be present in any reel, coil, or spool of the nominal specified mass.

13. Workmanship, Finish, and Appearance

13.1 The wire shall be free of all imperfections not consistent with good commercial practice.

14. Sampling, Testing, and Conformance Criteria

14.1 Sampling—Four test specimens shall be obtained, one from each of four production units or in accordance with Specification B830 (see Explanatory Note 2).

14.2 Tensile strength, Elongation, and Resistivity:

14.2.1 Test Methods:

14.2.1.1 Tensile strength and elongation may be determined simultaneously. Obtain the tensile strength, using Test Methods B557, by dividing the maximum load resisted by the tensile specimen, with the tensile stress to be expressed in kips (1000 lbf) per square inch (ksi). Elongation is the percent increase in length of the tensile specimen as measured between gauge marks originally spaced 10 in. [254 mm] apart on the specimen. Elongation measurements are not required for wire less than 0.0500 in. in diameter. Should any part of the fracture take place outside the elongation gauge lines, or if examination of the tensile specimen indicates a flaw, the values obtained may not be representative and a test on another section of the specimen may be run.

14.2.1.2 Determine the electrical resistivity using Test Method B193.

14.2.2 Test Results—A numerical average for the tensile strength, elongation, and resistivity of the four specimens shall be calculated and shall be considered the lot average.

14.2.3 Conformance Criteria—To be considered in conformance, the lot average test results shall meet the “average for a lot” requirements of Table 2 or Table 3 and Table 4, and the test results of each specimen shall meet the “individual tests” requirements of Table 2 or Table 3 unless otherwise specified.

14.2.3.1 If the lot average results are in conformance, and all of the individual specimen results are in conformance, the lot shall be considered in conformance.

14.2.3.2 If the lot average result for one or more of the tested properties is not in conformance and one or more of the individual specimen results is also not in conformance, the lot shall be considered not in conformance.

14.2.3.3 If the lot average results are in conformance, but one or more of the individual specimen results are not in conformance, the lot shall be considered in conformance except that the production unit or units represented by the nonconforming specimen or specimens shall be rejected.

14.2.3.4 If the lot average results for one or more of the tested properties are not in conformance, but all the individual specimen results are in conformance, then additional test specimens and tests shall be required as follows:

(1) An additional six test specimens shall be obtained, one each from six production units other than the four originally sampled. Test shall be run on the six additional specimens, and a numerical average of the ten tested specimens shall be calculated and considered the lot average.

(2) If the ten specimen lot average results are in conformance, and all ten of the individual specimen results are in conformance, the lot shall be considered in conformance.

(3) If the ten specimen lot average results for one or more of the tested properties are not in conformance, or if one or more of the ten individual specimen results are not in conformance, the lot shall be considered not in conformance.

(4) In the event a lot is rejected in accordance with 14.2.3.2 or (3), production units making up that lot may be individually tested. Acceptance of individual production units from a rejected lot shall be dependent on the individual specimen test results meeting the “average for a lot” requirements of Table 2 or Table 3 and Table 4.

14.3 Bending (brittleness)—Specimens from any production unit may be tested, with the frequency of sampling and testing to be agreed upon between the manufacturer and the purchaser.

15. Inspection

15.1 Unless otherwise specified in the purchase contract, the manufacturer shall be responsible for the performance of all inspection and testing requirements specified.

15.2 All tests and inspections shall be made at the place of manufacture unless otherwise agreed upon between the manufacturer and the purchaser.

15.3 The manufacturer shall afford the purchaser reasonable access to the manufacturer’s facilities consistent with the purchaser’s need to ensure compliance with this specification.