



# Standard Specification for Fine Aluminum–1 % Silicon Wire for Semiconductor Lead- Bonding<sup>1</sup>

This standard is issued under the fixed designation F487; 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–1 % silicon alloy wire for internal connections in semiconductor devices and is limited to wire of diameter up to and including 76  $\mu\text{m}$  (0.003 in.). For diameters larger than 76  $\mu\text{m}$  (0.003 in.), the specifications are to be agreed upon between the purchaser and the supplier.

1.2 The values stated in SI units are to be regarded as the standard, regardless of whether they appear first or second in a table. Values given in parentheses are for information only.

## 2. Referenced Documents

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

**F16** Test Methods for Measuring Diameter or Thickness of Wire and Ribbon for Electronic Devices and Lamps

**F219** Test Methods of Testing Fine Round and Flat Wire for Electron Devices and Lamps

### 2.2 Military Standard:<sup>3</sup>

**MIL-STD-105** Sampling Procedures and Tables for Inspection by Attributes

## 3. Ordering Information

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

3.1.1 Quantity,

3.1.2 Size (see Section 5),

3.1.3 Breaking load and elongation (see Section 4),

3.1.4 Packaging and marking (see Section 11), and

3.1.5 Special requirements, such as for certificate of compliance (see Section 10).

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials, Wire Bonding, and Flip Chip.

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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.

<sup>3</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

## 4. Physical Requirements

4.1 Elongation and breaking-load ranges for the wire shall be specified by the purchaser. The maximum ranges of these mechanical properties are listed in **Table 1**.

4.2 Mechanical property requirements in ranges smaller than those listed in **Table 1** may be specified upon agreement between the purchaser and the supplier.

NOTE 1—The nature of aluminum–1 % silicon alloy is such that the mechanical properties of both as-drawn and annealed wires overlap considerably. It is also possible to alter the properties of hard wire by varying the manufacturing parameters and procedures. For these reasons, no distinction is made between the two types of wire in this specification.

## 5. Dimensions, Weights, and Permissible Variations

5.1 Wire size shall be expressed in terms of wire diameter in decimal fractions of millimetres (inches). Tolerances for various size ranges are specified in **Table 2**.

5.2 When wire size is expressed in terms of weight, the following values shall be used:

5.2.1 *Density of Aluminum–1 % Silicon*—2.7  $\text{g}/\text{cm}^3$ .

5.2.2 *Weight of a 200-mm Length of Wire 25.4  $\mu\text{m}$  in Diameter*—0.274 mg.

## 6. Surface Finish

6.1 The wire surface shall be clean and free of finger oils, lubricant residues, stains, and particulate matter.

6.2 Mechanical damage to the wire surface, such as nicks, scratches, and kinks, shall be held to a minimum.

6.3 The inspection shall be carried out by electronic, optical, or other inspection method is agreed upon between the purchaser and the supplier. The nature and extent of defects permitted to be present on the surface of the wire shall be agreed upon between the purchaser and the supplier.

## 7. Chemical Requirements

7.1 The alloy composition shall be  $1.00 \pm 0.15$  % silicon, and between 98.84 and 99.15 % aluminum. All other elements are considered impurities.

7.2 No single impurity shall exceed 0.0050 % and the total of all detectable impurities shall not exceed 0.01 %.

**TABLE 1 Typical Elongation and Breaking Load of Aluminum–1 % Silicon Alloy Wire**

NOTE 1—Select the desired nominal breaking load and elongation for the wire by specifying a range of mechanical properties that includes the desired values.<sup>A</sup>

Nominal Diameter, in. (mm)	Breaking Load, g			Elongation, %		
	Min	Max	Max Range <sup>B</sup>	Min	Max	Max Range <sup>C</sup>
0.0007 (0.018)	3	12	2	0.5	3.0	2.0
0.0010 (0.025)	12	22	3	0.5	4.0	2.5
0.0012 (0.030)	14	30	3	0.5	4.0	2.5
0.00125 (0.032)	15	32	3	0.5	4.0	3.0
0.0015 (0.038)	20	50	4	0.5	4.0	3.0
0.0020 (0.051)	32	90	6	1.0	4.0	3.0

<sup>A</sup>Example: Wire of 25- $\mu$ m (0.001-in.) diameter with a breaking load of 16 g and an elongation of 2.0 % is desired. Specify a breaking-load range of 14 to 18 g (16  $\pm$  2 g) and an elongation range of 1.0 to 3.5 % (2.0 + 1.5 %, 2.0 – 1.0 %). (Note—Smaller ranges are acceptable; for this example, ranges of 15 to 17 g and 1.0 to 3.0 % could be specified. For diameters larger than 0.0020 in. (0.051 mm), the specifications are to be agreed upon between the purchaser and the supplier.)

<sup>B</sup>A range of permissible breaking strength of no more than the number of grams shown shall be selected from within the overall range designated by the minimum and maximum values for the given diameter.

<sup>C</sup>A range of permissible elongation of no more than the number of percentage points shown shall be selected from within the overall range designated by the minimum and maximum values for the given diameter.

**TABLE 2 Dimensional Tolerances**

Nominal Diameter, in. (mm)	Diameter Tolerance, % of nominal	Weight Tolerance, % of nominal
0.0005 to 0.0020 (0.013 to 0.051), incl	$\pm 3$	$\pm 6$

7.3 Any lower or higher impurity content shall be as agreed upon between the purchaser and the supplier as part of the purchase contract.

7.4 Larger aluminum wire diameters often include nickel or other impurities or both to minimize corrosion in plastic packages. Such wire is not covered by this specification.

**8. Sampling**

8.1 Unless otherwise agreed upon by the purchaser and the supplier, conformance with Section 4 shall be determined by MIL-STD-105.

**9. Test Methods**

9.1 *Elongation and Breaking Load*—Determine elongation and breaking load in accordance with Test Methods F219.

9.2 *Dimensional Measurement*—Determine the wire diameter by one of the following methods:

9.2.1 Measure the diameter directly in accordance with Test Methods F16.

9.2.2 Measure the diameter by optical means agreed upon between the purchaser and the supplier.

NOTE 2—Optical methods for measuring wire diameter are under development by Committee F-1 on Electronics.

9.3 *Chemical Analysis*—Verify that the chemical requirements are satisfied by means of spectrographic analysis or other means agreed upon between the purchaser and the supplier.

**10. Certification**

10.1 When agreed upon in writing by the purchaser and the supplier, a certification shall be made the basis of acceptance of the material. This shall consist of a copy of the manufacturer’s test report or a statement by the supplier, accompanied by a copy of the test results, that the material has been sampled, tested, and inspected in accordance with the provisions of this specification. Each certification so furnished shall be signed by an authorized agent of the supplier or the manufacturer.

**11. Packaging (Spooling) and Package Marking**

11.1 The type of spool shall be specified as agreed upon between the purchaser and the supplier. (For aging properties see the shelf life aging test, in Appendix X1.)

NOTE 3—Types of spools recommended for fine lead-bonding wire will be agreed upon by purchaser and manufacturer that are compliant with the user’s intended bonding machines.

11.2 The maximum and minimum length of wire on a spool shall be as specified by the purchaser.

11.3 The wire shall be wound so that it despoils freely and will be free of kinks and nicks. Spools shall be free of nicks, burrs, and dents. The beginning and end of the wind shall be clearly identified. The method of termination shall be as agreed upon between the purchaser and the supplier.

11.4 The wire shall be protected against damage in normal handling and shipping. The outer container shall bear markings indicating “fragile” contents and designating the proper end to be “up” in order to maintain spool axes horizontal during shipping. The outer container shall also be marked “Extremes of Temperature Must Be Avoided.”

NOTE 4—Other package marking should be specified by the purchaser if required.

11.5 The basic packing unit shall be legibly marked with the following information:

- 11.5.1 Material description,
- 11.5.2 Diameter, in. (or mm),
- 11.5.3 Length, metres (or feet),
- 11.5.4 Elongation and breaking-load specifications,
- 11.5.5 Melt or bar number,
- 11.5.6 Date of packaging,
- 11.5.7 User’s part number, and
- 11.5.8 Manufacturer’s name and product designation, if any.

**12. Keywords**

- 12.1 silicon aluminum wire; wire bonding

APPENDIX

(Nonmandatory Information)

X1. SHELF LIFE AGING TEST 1983–1985

X1.1 Purpose

X1.1.1 To determine the effect of room temperature aging on the stress-strain characteristics of bonding wires of several compositions and tempers.

X1.2 Test parameters

X1.2.1 *Environment*—Typical stock room,  $22.8 \pm 1.7^\circ\text{C}$  ( $73 \pm 3^\circ\text{F}$ ).

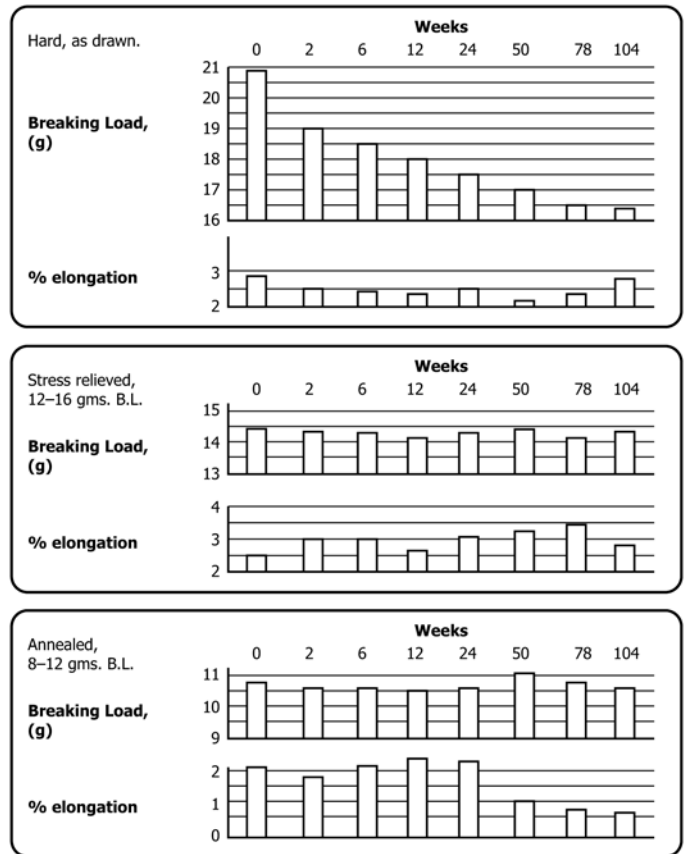
X1.2.2 *Spooling*—2-in. diameter, Aluminum, 100 ft/spool.

X1.2.3 *Instrument*—Instron type, 1 in./min., 10 in. length.

X1.2.4 *Sampling*—Average of five readings per notation.

X1.2.5 *Time*—Intervals shown on charts, see Fig. X1.1.

X1.2.6 *Wire Size*—All specimens, 25- $\mu\text{m}$  (0.001-in.) diameter.



NOTE 1—These data were taken in the 1980s. However, the metallurgy of 2012 Al-Si wire is unchanged and the data are considered correct for this purpose today.

FIG. X1.1 Aging Chart 1 % Silicon Aluminum Bonding Wire Alloy

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