



Designation: F16 – 12 (Reapproved 2022)

# Standard Test Methods for Measuring Diameter or Thickness of Wire and Ribbon for Electronic Devices and Lamps<sup>1</sup>

This standard is issued under the fixed designation F16; 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 These test methods cover procedures for measuring the diameter or thickness of round and flat wire (ribbon) 0.060 in. (1.52 mm) maximum used in electronic devices and lamps.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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. Summary of Test Method

2.1 In order to provide reliable determinations of physical dimensions of wire and ribbon products, these test methods are designed to mechanically measure the diameter or thickness with a high degree of precision. These test methods are based on the use of a sensitive measuring head with calibrated pressure settings, shaped measuring anvils to reduce errors caused by material curvature or waviness, and a method for presetting the anvil spacing by means of gauge blocks or cylindrical master standards.

## 3. Significance and Use

3.1 The methods contained in this standard are intended primarily for referee use, for laboratory measuring, and for certifying size of standard samples used for checking other

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee F01 on Electronics and are the direct responsibility of Subcommittee F01.03 on Metallic Materials, Wire Bonding, and Flip Chip.

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measuring equipment that may be agreed upon between the supplier and the purchaser.

## 4. Apparatus

4.1 Either of two general types of apparatus may be used for measuring, depending on the accuracy desired and on the availability of certified cylindrical master standards for gauge setting, as follows:

4.1.1 *Apparatus A*—For use with cylindrical master standards for gauge setting.

4.1.2 *Apparatus B*—For use with gauge block standards for gauge setting.

4.2 *Apparatus A*, shown in Fig. 1, shall have the following features:

4.2.1 An adjustable anvil of the size and shape specified for the material to be inspected. The anvil shall be nonrotating and shall be adjustable for position by means of a micrometer or precision adjusting screw, with means for locking the anvil in any set position after adjustments have been made.

4.2.2 A sensing anvil of the size and shape specified for the material to be measured, linked directly to a sensing and indicating device of specified precision and sensitivity.

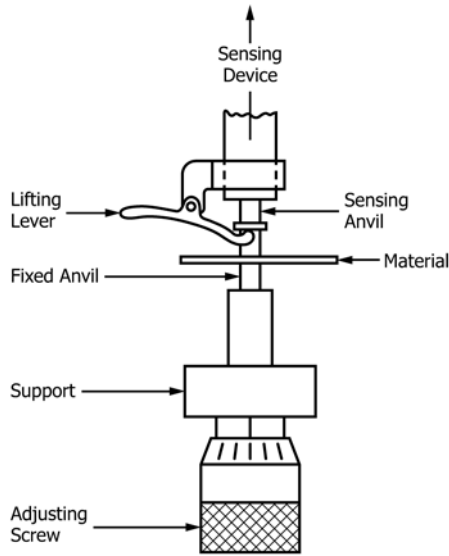
4.2.3 The adjustable fixed anvil and sensing anvil and the sensing device shall be rigidly mounted with both anvils in alignment on the same axis. The sensing anvil shall be movable with provisions for retracting the anvil for placing the specimen in the measuring position.

4.2.4 Both anvils shall be properly fitted, lapped, and polished so the contacting surfaces are flat and parallel within the accuracy specified.

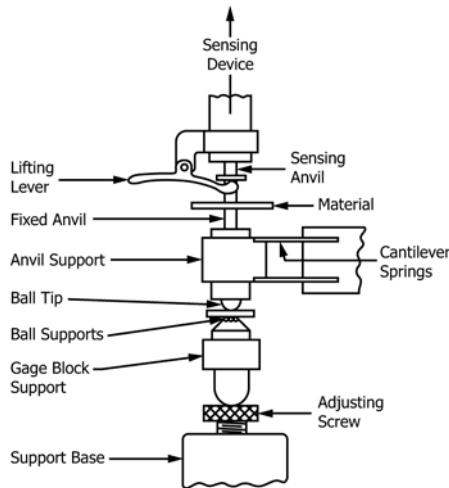
4.2.5 The sensing device shall be provided with a means for setting the indicator hand or scale to zero, and a calibrated scale or dial for setting the sensing anvil measuring pressure to the specified value required for measuring. This setting shall be accurate to within  $\pm 10\%$  of the set value.

4.3 *Apparatus B*, shown in Fig. 2, shall meet the requirements specified for Apparatus A in 4.2 with the following additional features:

4.3.1 The fixed anvil and support to which it is attached shall be free to move along the measuring axis but shall be held in line with the sensing anvil by means of cantilever springs so that parallelism with the sensing anvil is maintained. The



**FIG. 1 Measuring Apparatus A for Use with Cylindrical Master Standards for Gauge Setting**



**FIG. 2 Measuring Apparatus B for Use with Gauge Block Standards for Gauge Setting**

opposite end of the movable anvil support shall terminate in a ball contact having a diameter from 0.19 in. to 0.25 in. (4.8 mm to 6.4 mm). The total pressure of the support and springs shall exert a force of  $500 \pm 0$  g on the gauge block.

4.3.2 The gauge block for setting shall be located directly in contact with the movable anvil support ball contact. The opposite side of the gauge block shall be supported at three places by hardened steel balls 0.09 in. to 0.12 in. (2.4 mm to 3.2 mm) in diameter and equilaterally spaced to form a triangle.

4.3.3 The three ball contacts shall be securely fixed to a support table and shall be movable for setting the measuring device by means of a precision adjusting screw. Provision shall be made for securely locking the table in place after setting.

## 5. Test Specimens

5.1 Test specimens shall be selected at least 3 ft (0.9 m) from the end of a spool or coil of material and shall be straight

and free from kinks, dents, or other damage that would interfere with measuring accuracy.

5.2 Wire or fine ribbon shall be drawn from the spool under uniformly low tension to prevent elongation. If the material is obviously contaminated with oil, dirt, or other foreign matter, it shall be drawn gently through a lint-free cloth, wet with a suitable solvent.

## 6. Test Conditions

6.1 The measuring device shall be used in a location that is clean and free of dust and lint. Vibration, drafts, direct heat from lamps, and temperature variations shall be minimized. The equipment shall be kept clean and covered when not in use.

6.2 For fine wire, smaller than 0.0008 in. (0.02 mm) in diameter, extra precautions shall be taken to avoid all possible causes (see 6.1) of inaccurate measurements. The measuring devices shall be used in a small gauge laboratory with temperature variations kept to within  $\pm 5$  °C. The equipment shall be laid out on a clean surface with tools and gauge blocks on foam rubber pads. All equipment used for measuring, and the material samples, shall be stabilized by leaving them together in the gauge room for at least 1 h. Gauge blocks shall be handled with tongs to prevent temperature variations.

6.3 Gauge blocks shall be recalibrated at least once every year, using the block calibration size for the calibration setting. Blocks must be carefully cleaned and handled to prevent uneven wear with consequent introduction of errors into the gauge setting.

6.4 The device shall be cleaned, calibrated, and set for measuring by means of certified gauge blocks or cylindrical master standards as specified in Section 11.

## 7. Setting Measuring Apparatus

7.1 Set the measuring apparatus by means of standards so that the indicator hand or scale of the sensing device is at zero when adjusted for the nominal size of the material to be measured. This shall be done by means of certified cylindrical master standards for Apparatus A and by means of certified gauge blocks for Apparatus B.

7.2 Cylindrical master standards shall be certified for diameter, roundness, and surface finish by a metrology laboratory. The master cylinders of wire shall be made of hardened steel having a Rockwell hardness of 63 to 65 HRC, and lapped to a finish of 1  $\mu$ m. rms or a 4- $\mu$ m. height (0.0001 mm).

7.3 Gauge blocks shall be certified for length, flatness, parallelism, and surface finish by a metrology laboratory. The exact thickness of the blocks shall be reported to the nearest microinch (0.000025 mm) as measured near the center of each block. The surface finish shall be equivalent to 1  $\mu$ m. rms or a 4- $\mu$ m. (0.0001 mm) height or better.

7.4 Set Apparatus A for the nominal material size to be measured by placing a cylindrical master standard between the two anvils and adjusting the fixed anvil adjusting screw to get a zero reading on the sensing device. Raise and lower the