



Designation: **F458—06 F458 – 13**

Standard Practice for Nondestructive Pull Testing of Wire Bonds^{1,2}

This standard is issued under the fixed designation F458; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice covers nondestructive testing of individual wire bonds made by either ultrasonic, thermal compression or thermosonic techniques. The test is ~~destructive to~~ intended to reveal (by breaking) nonacceptable wire bonds but is designed to avoid damage to acceptable wire bonds.

NOTE 1—Common usage at the present time considers the term “wire bond” to include the entire interconnection: both welds and the intervening wire span.

1.2 The practice covers wire bonds made with small-diameter (from 0.0007 to 0.003-in. (18 to 76- μ m)) wire ~~of such as~~ the type used in integrated circuits and hybrid ~~microcircuits~~ microcircuits, system in package, and so forth.

1.3 This practice can be used only when the loop height of the wire bond is large enough to allow a suitable hook for pulling to be placed under the wire.

1.4 While the procedure is applicable to wire of any composition and metallurgical state, criteria are given only for gold and aluminum wire.

1.5 A destructive pull test is used on wire bonds of the same type and geometry to provide the basis for the determination of the nondestructive pulling force to be used in this practice. This may only be used if the sample standard deviation, s , of the pulling forces required to destroy at least 25 of the same wire bonds tested by the destructive pull-test method is less than or equal to 0.25 of the sample average, \bar{x} . If $s > 0.25 \bar{x}$, this practice may not be used.

NOTE 2—If $s > 0.25 \bar{x}$, some aspect of the bonding process is out of control. Following corrective action, the destructive pull-test measurements should be repeated to determine if the $s \leq 0.25 \bar{x}$ criterion is met.

1.6 The nondestructive wire-bond pull test is to be performed before any other treatment or screening following bonding and at the same point in processing as the accompanying destructive test. Preferably, this is done immediately after bonding.

1.7 The procedure does not ensure against wire-bond failure modes induced after the test has been performed.

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

1.9 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards*:³

[F459 Test Methods for Measuring Pull Strength of Microelectronic Wire Bonds](#)

2.2 *Military Standard*:⁴

[MIL-STD-883 Method 2023](#)

¹ This practice is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.07 on Wire Bonding, Flip Chip, and Tape Automated Bonding.

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² This procedure, with current status and limitations, was published in: Harman, G. G., *Wire Bonding in Microelectronics*, 3rd Edition, McGraw Hill, 2010, Appendix 4B.2.

³ 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.

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

3. Summary of Practice

3.1 The use of nondestructive wire-bond pull tests is predicated on data obtained from destructive pull tests on typical samples selected from a lot. The maximum safe nondestructive pull-force levels are determined as a function of the metallurgical properties of the wire and from the calculated mean (\bar{x}) and standard deviation (s) of the destructive pull-test data determined in accordance with Test Methods F459.

3.2 In some cases, rather than use a calculated nondestructive pull force, a fixed pull force may be agreed upon by test participants. This value may be based upon industry practice, or some other accepted value, such as that in MIL STD 883, Method 2023. All other parts of the present ASTM standard will apply.

3.3 The maximum safe nondestructive bond-pull force is then applied as a screen for individual wire bonds to identify all bonds with pull strength below the predetermined level of acceptability.

4. Significance and Use

4.1 The nondestructive wire-bond pull test provides a screen for evaluating wire-bond quality and is capable of detecting weak or nonadherent bonds.

4.2 The test is not destructive ~~to~~ and does not damage acceptable wire bonds.

4.3 This practice provides a procedure for identifying a bonding situation that requires corrective action.

4.4 The purpose of this practice is to identify wire bonds that may fail during subsequent screening procedures or field operation.

4.5 The procedure is to be applied after bonding and before any further treatment.

5. Interferences

5.1 The same interferences apply as given in Test Methods F459 (Section 6, ~~Interferences~~); Interferences; in addition this test cannot be used on multi-tiered devices.

6. Apparatus

6.1 The apparatus used for the procedure is identical to that used in Test Methods F459 except that the lifting mechanism shall have the capability of stressing the wire bond up to a predetermined level. As this predetermined level may change in accordance with the results of a successive series of tests using Test Methods F459, as well as to accommodate changes in wire composition and metallurgy, the lifting mechanism must be capable of applying an adjustable maximum force.

7. Sampling

7.1 As the test is ~~nondestructive,~~ nondestructive. As such it may be used as a 100 % production line screen so that sampling is not required.

7.2 The test may be used as a lot acceptance test with the sampling scheme agreed to by the participating parties.

8. Calibration and Standardization

8.1 Calibrate the nondestructive stressing device in the same manner as is used in calibrating the destructive wire-bond pull-test apparatus as specified in Test Methods F459.

8.2 Carry out the destructive wire-bond pull test in accordance with either Method A or B of Test Methods F459, whichever is appropriate to the particular wire bond being tested. Use a rate of force application within the range from 1 to 30 gf/s (10 to 290 mN/s) inclusive. Record the force required to break the wire bond, as well as identifying the wire bond, the device, and whether Method A or B was used.

8.2.1 For noncontinuous use of a particular bonding machine, apply either Method A or Method B (whichever is appropriate) of Test Methods F459 to a minimum sample of at least 25 of the same wire bonds once the bonding machine has been turned on, thermally stabilized, and ~~tuned (if the machine is not self-tuning),~~ set up by the manufacturers' procedure.

8.2.2 For continuous use of a particular bonding machine, apply either Method A or B (whichever is appropriate) of Test Methods F459 to a sample of approximately 0.1 % (at least 25 bonds) of the particular wire bond under study after every 2-h period of bonding.

8.3 Given a set of n observed values of the destructive wire-bond pull strength $\{x_i\}$, $i = 1, \dots, n$, calculate the mean, \bar{x} , and the standard deviation, s , of the destructive wire-bond pull test in accordance with the following:

8.3.1 Calculate the average wire-bond pull strength, \bar{x} , as follows:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$