Designation: F 357 – 78 (Reapproved 2002)

Standard Practice for Determining Solderability of Thick Film Conductors [1]

This standard is issued under the fixed designation F 357; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers a procedure for determining the solderability of thick-film conductors. The procedure has been adapted from several techniques that are in routine use for testing this property.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Terminology

2.1 *Definition:*

2.1.1 *solderability*—the ability to accept or be wetted by solder.

3. Summary of Practice

3.1 Conductor ink is screened and fired onto a substrate by means of appropriate conventional screening techniques and firing cycles. A sphere of the solder to be used is placed on the surface of the fired conductor with an appropriate flux. The system is heated to soldering temperature, maintained at that temperature for a fixed time, and cooled rapidly. The solderability of the conductor is graded on the basis of the measured diameter of the solder ball after it has passed through the heat cycle.

4. Significance and Use

4.1 The procedure of this practice is suitable for process control.

4.2 No interlaboratory precision has been established for the procedure of this practice. Therefore, this practice should not be used for the acceptance or rejection of material exchanged between buyers and sellers.

5. Apparatus

5.1 *Electric Hot Plate* (or other suitable heat source such as a bath of molten solder) with an area about 6 by 6 in. (150 by 150 mm) or larger, capable of maintaining a temperature 50 ± 5°C above the melting point of the solder under test.

5.2 *Cast Iron Plate*, approximately 6 by 6 by ½ in. (150 by 150 by 13 mm).

NOTE 1—It is recommended that the plate be coated on all faces with a 0.001 in. (0.03 mm), max, thickness of poly(tetrafluoroethylene) to prevent spilled solder from wetting and adhering to the plate.

5.3 *Surface Temperature Pyrometer* with an accuracy better than ±2 % over the temperature range of the test.

5.4 *Chill Block* of steel or aluminum approximately 6 by 6 by 1 in. (150 by 150 by 25 mm).

NOTE 2—If large quantities of parts are being tested, it is advantageous to water cool the chill block.

5.5 *Timer*, capable of indicating a time interval of 30 s to the nearest 0.2 s.

5.6 *Machinist's Microscope* or microscope with calibrated measuring reticle capable of indicating diameters between 0.010 and 0.050 in. (0.25 and 1.27 mm) with a resolution of approximately 0.0005 in. (0.013 mm).

6. Materials

6.1 *Solder Balls*, 0.018 ± 0.001 in. (0.46 ± 0.03 mm) in diameter, in quantity, composition, and purity appropriate to the conditions of the test (see 7.3).

6.2 *Flux* appropriate to the solder-conduct or system under test.

6.3 *Blank Substrates* of suitable type and quantity (see 7.3) for the system under test.

7. Test Specimen

7.1 The test specimen shall be prepared by screening conductor ink onto a substrate by means of conventional techniques and fired according to the desired cycle, as agreed upon by the parties to the test. It is recommended that the thickness of the fired conductor be 0.0005 in. (0.013 mm) or greater and that the minimum width be 0.08 in. (2.0 mm).

[1] This practice is under the jurisdiction of Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials.

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7.2 Alternatively the specimen to be tested may be selected from a batch of fired conductors according to procedures agreed upon by the parties to the test.

7.3 Due to the qualitative nature of this test and to random variations in materials, a single test can give misleading results. Therefore, a statistically valid sample should be employed. A total of 30 measurements obtained from 10 substrates each containing 3 solder balls is recommended.

8. Procedure

8.1 Place the cast iron plate on the hot plate.

8.2 Place a blank substrate on the cast iron plate and place the surface temperature pyrometer on top of the blank substrate.

8.3 Heat the hot plate until the surface temperature pyrometer indicates that a stable temperature 50 ± 5°C above the melting point of the solder to be tested has been maintained for at least 5 min.

8.4 Apply an appropriate flux to the surface of the fired conductor to be tested and place a solder ball of the proper composition and purity on the fluxed region.

8.5 Place the test specimen on the preheated hot plate with the fluxed region and solder ball upward. Observe the solder ball carefully and begin timing as soon as the solder begins to melt or collapse.

8.6 After 30 ± 1 s remove the test specimen and place it on the chill block which is maintained at a temperature close to room temperature but not over 30°C.

8.7 After the test specimen is cool, measure two approximately perpendicular diameters of the solder ball with the calibrated microscope and record the diameters.

8.8 Repeat 8.1-8.7 until the measurements required under the test plan have been obtained (see 7.3).

9. Interpretation of Results

9.1 Calculate the average diameter in accordance with the data of 8.7 and the test plan (see 7.3).

9.2 Assign letter grades to the solderability of the fired conductor according to the calculated average diameter:

9.2.1 *A*—The diameter is less than 0.028 in. (0.71 mm). Typically, in this case, no significant wetting has occurred and there is no evidence of a collapse of the solder ball or of a fillet at the solder-conductor interface.

9.2.2 *B*—The diameter is from 0.028 in. (0.71 mm) to 0.037 in. (0.94 mm), max. Typically, in this case, there is at least a noticeable collapse of the solder ball and a fillet can be observed at the solder-conductor interface.

9.2.3 *C*—The diameter is greater than 0.037 in. (0.94 mm) but not over 0.045 in. (1.14 mm). Typically, in this case, the solder ball has collapsed significantly, but it retains a circular appearance as viewed through the microscope.

9.2.4 *D*—The diameter is greater than 0.045 in. (1.14 mm) or is unmeasurable. This grade includes the case of dissolution in which the solder is completely dissolved into the conductor and little or no evidence of the solder remains.

10. Keywords

10.1 hybrid microcircuits; solderability; solder wetting; thick-film metallization