Association Connecting Electronics Industries

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Number	
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Subject	
Service Temperature of Flexible Printed Boards	
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Originating Task Group	
Flexible Circuits Test Methods Subcommittee (D-15)	

IPC-TM-650
TEST METHODS MANUAL

1 Scope This test method describes the procedure for establishing the service temperature for flexible metal-clad laminate as described in IPC-4204. The application of this method will allow the user to examine the dielectric strength, peel strength and any visual anomalies that occur after thermal aging.

2 Applicable Documents

2.1 IPC[1]

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-TM-650 Test Methods Manual[2]

2.4.9 Peel Strength, Flexible Dielectric Materials

2.4.13 Solder Float Resistance Flexible Printed Wiring Materials

2.2 ASTM International[3]

ASTM D-149 Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies[1]

3 Bond Strength Test Procedure for Base Metal-clad Laminate

3.1 Sample Preparation Prepare twelve specimens according to the procedure outlined for method A of IPC TM-650, method 2.4.9, using appropriate photolithographic processes. Etch four conductors 3.2 mm [0.126 in] wide, 5.7mm [0.224 in] pitch, 230 - 250 mm [9 - 10 in] long on a nominal 25 mm [1 in] wide strip of flexible dielectric (see Figure 1).

The material, single-clad or double-clad, shall be tested in the construction supplied. If the material under test is double-clad, prepare a separate set of samples for each side. It is permissible to leave the unetched copper on the non-test side. (See Notes 5.1 and 5.2)

3.2 Conditioning and Aging Procedure

3.2.1 Twelve samples, as described in 3.1 **shall** be stabilized for a minimum of 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% ± 5% RH.

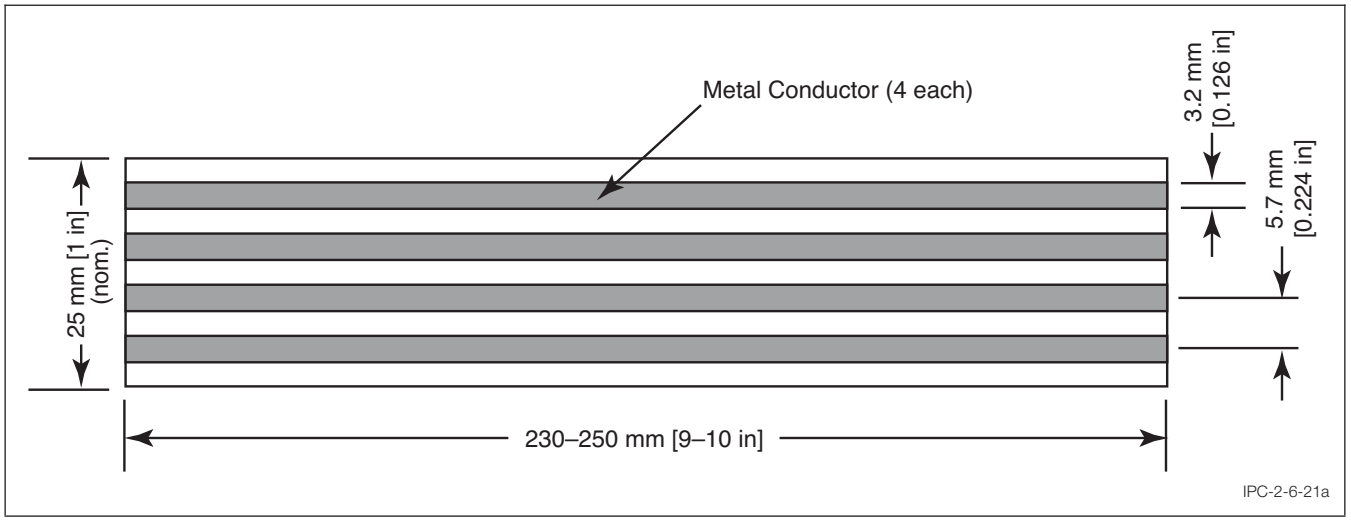

Figure 1 Test Sample for Evaluating Peel Strength of Metal-Clad Laminate Material

1. www.ipc.org
2. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/html/testmethods.htm)
3. www.astm.org

3.2.2 Measure the base dielectric thickness and the metal thickness of the twelve samples following the stabilization period in 3.2.1. Nominal metal thickness to be tested is either 35 µm thick [1380 µin] (preferred) or 18 µm [710 µin] thick.

3.2.3 For the stabilized samples from 3.2.1, accurately measure and record the conductor widths to two decimal places in metric and three decimal places in Imperial units to use in the peel strength calculation in 3.3.2.

3.2.4 Examine the twelve samples measured in 3.2.3 using normal or corrected 20/20 (also termed 6/6 or 1.0) vision, and discard peel strips showing the presence of wrinkles, cracks, blisters, or loose conductors. Twelve specimens are required for the test, so any samples not meeting this criterion must be replaced.

3.2.5 Per IPC-TM-650, TM 2.4.13, Method B, subject the samples examined in 3.2.4 to pre-drying and then solder float. (See Notes 5.3 and 5.4)

3.2.6 Examine the twelve samples subjected to solder float in 3.2.5 using normal or corrected 20/20 (also termed 6/6 or 1.0) vision, and record the presence of wrinkles, cracks, blisters, or loose conductors. Discard peel strips showing the presence of wrinkles, cracks, blisters, or loose conductors.

3.2.7 Place six samples into an air-circulating oven at the desired Service Temperature value. The oven temperature **shall** be held at a tolerance of ± 3 °C. The samples are to continuously remain in the oven for 1000 hours, -0 hours / +12 hours.

3.2.8 After being aged per 3.2.7, the test samples **shall** be cooled to room temperature at standard ambient laboratory conditions. After being cooled to room temperature, the thermally aged (oven conditioned) samples **shall** be subjected to a stabilization period of a minimum of 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% ± 5% RH.

3.2.9 After the stabilization period in 3.2.8, examine the samples using normal or corrected 20/20 (also termed 6/6 or 1.0) vision, and record the presence of wrinkles, cracks, blisters, or loose conductors, or delamination.

3.3 Measurement of Peel Strength

3.3.1 AABUS, test samples may have rigid reinforcement material attached to all twelve samples that were subjected to the solder float in 3.2.5, including those six samples that were additionally subjected to thermal aging in 3.2.7. The attachment of the rigid reinforcement material depends on a number of factors, including the type of peel test apparatus as described in IPC-TM-650, Method 2.4.9. If the rigid reinforcement material is to be utilized, it should be adhered to the samples using double-faced adhesive tape or appropriate adhesive system to the back side of the samples.

If the test samples are generated from double-clad materials with metal remaining on the non-test side, the additional rigid reinforcement material is unnecessary and should not be used.

3.3.2 Measure the peel strength of the twelve conductors (one conductor strip per each set of four strips for each material under test) per the procedures outlined in IPC TM-650, Method 2.4.9. Specifically, make these 90° peel angle measurements at a 50.8 mm per minute crosshead speed.

3.4 Evaluation and Recording of Results

3.4.1 Calculate the average peel strength of six peel strips, one strip per each of the six ''as-received'' samples that were only exposed to the solder float (i.e., only as per 3.2.5 and *not* exposed to the thermal aging of 3.2.7). Calculate the average peel strength of six peel strips, one strip per each of the six ''thermally aged'' samples per 3.2.7. Calculate the ratio of the ''thermally aged'' average peel strengths divided by the ''as-received'' average peel strength to determine the percentage retention of peel strength. Record this number to ±1% accuracy.

$$\frac{\text{[Ave. of Six (6) Peel Strengths of ''Thermally Aged'' Samples]}}{\text{[Ave. of Six (6) Peel Strengths of ''As Received'' Samples}} \times 100 = \%\ \text{of Peel Strength Retained}$$

3.4.2 Record the results of the visual examination evaluation in 3.2.9.

4 Dielectric Strength Using ASTM D-149 Test Procedure

4.1 Sample Preparation

4.1.1 Prepare a sample of the flexible clad laminate large enough {approximately 400 mm x 500 mm [16 in x 20 in]} to prepare at least twelve test specimens each of 80 mm x 80 mm [approx 3.0 in x 3.0 in]. Remove (etch) all metal from both surfaces of the 400 mm x 500 mm [16 in x 20 in] sample by standard industry practice. Rinse the etched material thoroughly. Cut the minimum of twelve test specimens to their nominal size of 80 mm x 80 mm [approx 3.0 in x 3.0 in].

4.2 Conditioning and Aging Procedure

4.2.1 After generating the minimum of twelve samples as described in 4.1.1, all samples **shall** be stabilized for a minimum of 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% RH ± 5% RH.

4.2.2 Examine at least twelve samples using normal or corrected 20/20 (also termed 6/6 or 1.0) vision, and record the presence of wrinkles, cracks or blisters. Discard those samples showing the presence of wrinkles, cracks or blisters.

4.2.3 Subject twelve samples that were examined and passed the inspection in 4.2.2 to solder float per IPC-TM-650, TM 2.4.13, Method B. All twelve samples **shall** then be subjected to a stabilization period of a minimum of 24 hours at 23 °C ± 2 °C [73.4 °F ± 3.6 °F] and 50% RH ± 5% RH.

4.2.4 Examine the twelve samples subjected to the solder float and subsequent stabilization period in 4.2.3 using normal or corrected 20/20 (also termed 6/6 or 1.0) vision, and record the presence of any wrinkles, cracks or blisters. Ensure that no solder remains in the area to be tested.

4.2.5 Six samples subjected to the solder float in 4.2.3 and examined in 4.2.4 **shall** be placed into an air-circulating oven at the desired Service Temperature value. The oven temperature **shall** be held at a tolerance of ± 3 °C [± 5.4°F]. The samples are to continuously remain in the oven for 1000 hours, -0 hours / +12 hours.

4.2.6 After being oven-conditioned as described in 4.2.5, the test samples **shall** be cooled to room temperature at standard ambient laboratory conditions. After being cooled to room temperature, the oven-conditioned samples **shall** be subjected to a stabilization period of a minimum of 24 hours at 23 °C ± 2°C [73.4 °F ± 3.6 °F] and 50% ± 5% RH.

4.2.7 After the stabilization period in 4.2.6, examine the six samples that had been subjected to the oven-conditioning using normal or corrected 20/20 (also termed 6/6 or 1.0) vision, and record the presence of any wrinkles, cracks or blisters.

4.3 Measurement of Dielectric Strength

4.3.1 The six samples that were subjected to solder float and stabilization in 4.2.3 but not subjected to the oven-conditioning in 4.2.5 **shall** be subjected to the dielectric strength test per ASTM D-149. (These measurements **shall** be considered the ''as-received'' dielectric strength values.)

4.3.2 The ''thermally aged'' (oven-conditioned) samples examined in 4.2.7 **shall** be tested for dielectric strength according to the conditions outlined in 4.3.1 (These measurements **shall** be considered the ''thermally-aged'' dielectric strength values.)

4.4 Evaluation of results

4.4.1 Calculate the average dielectric strength of the six ''as-received'' samples (one dielectric strength value for each of the six ''as-received'' samples) as measured in 4.3.1. Calculate the average dielectric strength of the six ''thermally aged'' samples (one dielectric strength value for each of the six ''thermally aged'' samples) as measured in 4.3.2. Calculate the ratio of the average value of the ''thermally aged'' dielectric strength divided by the average value of the ''as-received'' dielectric strength to determine the percentage retention of dielectric strength. Record this number to ± 1% accuracy.

$$\frac{\text{[Ave. of Six (6) Diel. Strengths of ''Thermally Aged'' Samples]}}{\text{[Ave. of Six (6) Diel. Strengths of ''As Received'' Samples}} \times 100 = \%\ \text{of Peel Strength Retained}$$

5 Data Reporting

5.1 Report both % values calculated in sections 3.4.1 and 4.4.1. The Service Temperature value, in units of °C, **shall** be based upon the *lesser* of the two reported % values calculated in sections 3.4.1 and 4.4.1.

6 Notes

6.1 For sample preparation, test results may vary between samples where the copper remains and those that have had the copper removed from the nontest side. If the material is supplied as single-clad and double-clad, both must be tested.

6.2 For sample preparation, test results may vary for the same material, depending whether it is tested as single or double clad.

6.3 After solder float, suitable procedures must be used to ensure that solder does not remain on the test specimens.

6.4 For the solder float exposure and for materials other than polyimide, the temperature of the solder pot may be other than 288 °C [550 °F], AABUS.