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Number	
2.6.3.1	
Subject	
Solder Mask - Moisture and Insulation Resistance	
Date	Revision
03/07	**E**
Originating Task Group	
Solder Mask Performance Task Group (5-33b)	

IPC-TM-650
TEST METHODS MANUAL

1 Scope This test method is used to determine the moisture and insulation resistances of applied polymer solder mask under two separate prescribed conditions of temperature and humidity. One condition is described as Class T and the other Class H. Raw material qualification testing is performed on designated comb patterns. Production quality conformance testing is performed on a standard ''Y'' pattern.

2 Applicable Documents

IPC-A-25A-G-KIT[1] Multipurpose One-Sided Test Pattern - Gerber Format

IPC-SM-840 Qualification and Performance of Permanent Solder Mask

J-STD-004 Requirements for Soldering Fluxes

IPC-A-600 Acceptability for Printed Boards

3 Test Specimens The IPC-A-25A-G-KIT artwork package provides the Gerber files necessary for the fabrication of the standard IPC-B-25A test board used with this test method.

3.1 Qualification Testing

3.1.1 Class H Three IPC-B-25A boards using the D comb patterns with 0.32 mm [0.0126 in] lines/spaces (see Figure 1). Of which, two are to be coated and one uncoated with solder mask according to the solder mask supplier's recommendations.

3.1.2 Class T Three IPC-B-25A boards using the E and F comb patterns with 0.41 mm [0.016 in] lines and 0.51 mm [0.020 in] spaces (see Figure 1). Of which, two are to be coated and one uncoated with solder mask according to the solder mask supplier's recommendations.

3.2 Conformance Testing IPC-B-25A board C (''Y'' shape) pattern with 0.64 mm lines/0.64 mm spacing [0.025 in lines/0.025 in spacing] or pattern with minimum spacing on the production board (see Figure 1), whichever has the smallest line spacing, coated with solder mask according to the solder mask suppliers recommendations.

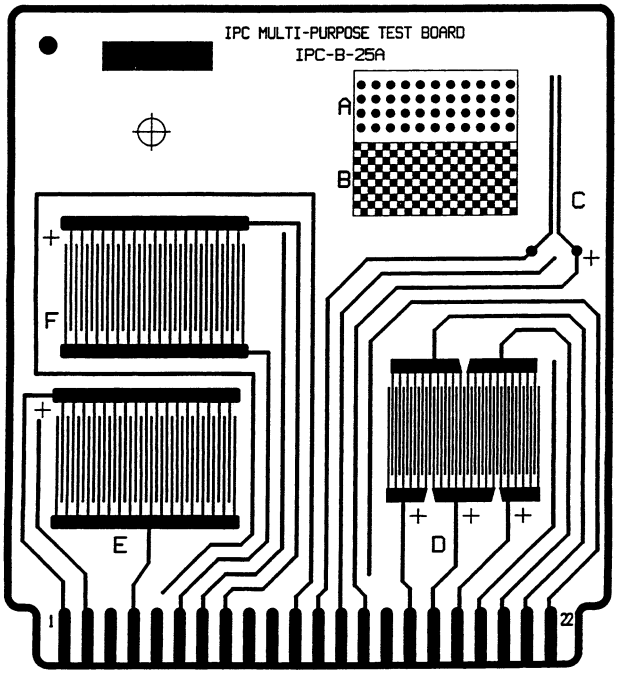

Figure 1 IPC-B-25A Test Board

4 Apparatus

4.1 Chamber A clean chamber capable of programming and recording an environment of 25 ± 2 °C [77 ± 3.6 °F] to at least 65 ± 2 °C [149 ± 3.6 °F] and 90-98% relative humidity.

NOTE: This test requires a clean chamber and clean water for repeatable test results. The following recommendations are made:

- Incoming water purity should be between 0.5 and 0.1 micro-siemens/cm.
- Fresh deionized water should be used for each test, rather than using a recirculating water sump.
- Chamber workspaces should be cleaned at least every six months.

1. www.ipc.org/onlinestore

4.2 Power Supply Capable of producing a standing bias potential of 100 VDC with a tolerance of ± 10%.

4.3 Resistance Meter Capable of reading high resistance (10^{12} ohms or greater), with a test voltage of 100 VDC.

4.4 Oven Capable of maintaining at least 120 °C [248 °F].

4.5 Timer

4.6 Solder Pot

4.7 Tongs

4.8 Soldering Iron

4.9 Flux Water white rosin (R or RMA) with halide content less than 0.5%, i.e., type Symbol A and B or ROL0 and ROL1 according to J-STD-004.

5 Test

5.1 Ambient Conditions Class T and Class H: 25 +2/-5 °C [77 +3.6/-9 °F] and 40 - 50% relative humidity.

5.2 Test Conditions

5.2.1 Class T 65 ± 2 °C [149 ± 3.6 °F], with 90 ± 3% relative humidity, no bias, static, 24 hours.

5.2.2 Class H 25 to 65 ± 2 °C [77 to 149 ± 3.6 °F], with 90 +3/-5% relative humidity, 50 VDC bias, 20 cycles (160 hours or 6⅔ days).

5.3 Specimen Preparation (Both Classes)

5.3.1 Positive, permanent and noncontaminating identification of the test specimens is of paramount importance.

5.3.2 Visually inspect the test specimens for any obvious defects, as described in IPC-A-600. If there is any doubt about the overall quality of any test specimen, the test specimen shall be discarded.

5.3.3 One uncoated specimen subjected to the same processing (except solder mask coating) as the coated specimens shall be supplied with each set of coated samples for testing as a control.

5.3.4 Subject one solder mask coated IPC-B-25A board to solder in accordance with J-STD-004. Clean any residual flux residue from the board surface using the following procedure:

1) Rinse with deionized or distilled water (30 seconds minimum).
2) Immerse the board in 2-propanol and agitate (30 seconds maximum). Gently scrub the board using a soft bristled brush while submersed.
3) Spray the board with clean 2-propanol.
4) Bake in an oven at 50 °C [122 °F] for three hours minimum.

5.4 Electrical Connections (Both Classes)

5.4.1 For qualification purposes, single stranded PTFE coated wire or some equivalent should be used to attach the appropriate test pads (designated in 3.1) to the power supply used for biasing and/or insulation resistance testing. When soldering the wires onto the pads care should be taken to ensure that the flux does not splatter onto the combs. A simple noncontact shield fixture should be used to protect the test patterns from flux splattering during soldering.

Note: An alternate method is to use gold plated alligator clips.

5.4.2 For quality conformance purposes, single stranded PTFE coated wire or an equivalent should be used to attach the appropriate test pads of pattern C to the power supply for insulation resistance testing.

5.5 Soldering Flux The flux shall not be removed.

Note: If the flux has contaminated the pattern on the control, the sample shall be discarded and a new one used. It cannot be cleaned because it will not represent the cleaning process that was used prior to solder mask application.

5.6 Specimen Handling For the remainder of the test, the surface of the test specimens either uncoated or coated with solder mask shall not be handled or exposed to any other contaminating influence. Handle all test specimens by the edges only.

5.7 Class H Procedures

5.7.1 Class H Testing

5.7.1.1 Place specimens in a chamber, in a vertical position and under a condensation drip shield. Condition the specimens at 50 ± 2 °C [122 ± 3.6 °F] with no added humidity, for a period of 24 hours.

5.7.1.2 Allow the specimens to cool, measure and record the initial insulation resistance measurements at ambient laboratory conditions. Apply 100 VDC on the specimen's test points as specified in 3.1.1 or 3.2 with the resistance meter and take the reading after one minute. See 6.2.

5.7.1.3 Connect the 50 VDC voltage source to each of the specimens test points as indicated in 3.1.1 or 3.2. Each chamber load shall contain at least one uncoated control board that is representative of the cleaning process used prior to solder mask application for each solder mask tested.

5.7.1.4 The test points for qualification tests are 1 to 2, 3 to 2, 3 to 4 and 5 to 4 on the D comb pattern. On the D comb pattern, test points 1, 3 and 5 are connected to the positive terminal and test points 2 and 4 are connected to the negative terminal of the resistance meter. For quality conformance, the pair of test points is 1 to 2 on the C pattern. One side of the C pattern should be connected to the negative terminal and the other side to the positive.

5.7.1.5 Close chamber door and apply a 50 volt bias to all comb patterns (D or C patterns) tested.

5.7.1.6 Expose test specimens to 20 cycles of temperature and humidity (see Figure 2). The bias voltage shall be maintained throughout the entire 20-cycle period. Humidity shall be maintained at 85% minimum through the cycles except when going to low temperature (see step c below), in which case the humidity may temporarily drop to 80% minimum.

One cycle is as follows:

a. Start test at 25 ± 2 °C [77 ± 3.6 °F] and raise the temperature to 65 ± 2 °C [149 °F] over a time span of 2.5 hours ± 5 minutes

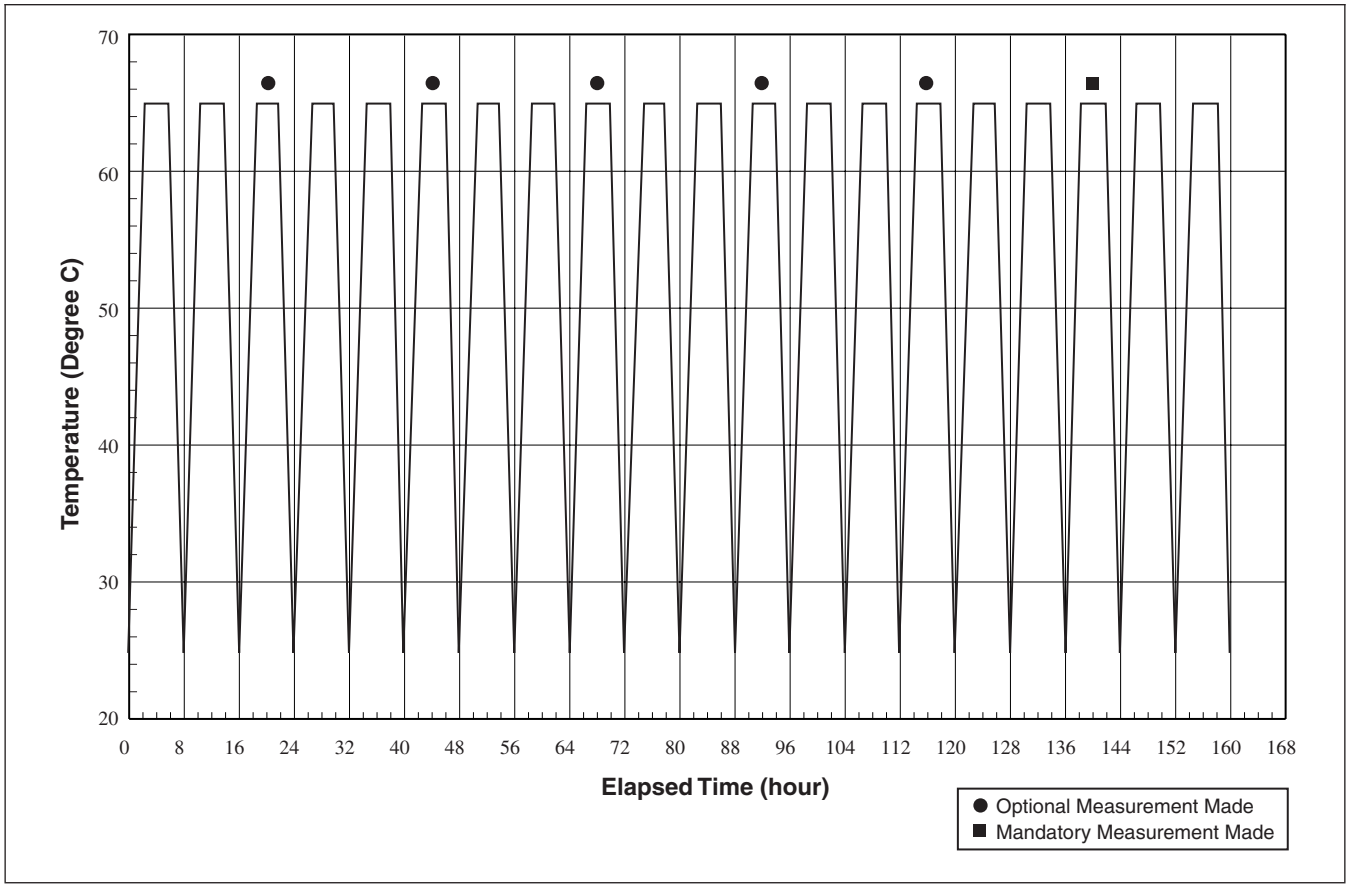

Figure 2 Moisture and Insulation Resistance Test Graph

b. Maintain temperature at 65 ± 2 °C [149 ± 3.6 °F] for 3, +0.5/-0 hours

c. Lower the temperature from 65 ± 2 °C [149 ± 3.6 °F] to 25 ± 2 °C [77 ± 3.6 °F] over a time span of 2.5 hours ± 5 minutes

Note: There shall be no delay between cycles.

5.7.2 Class H Measurement

5.7.2.1 Disconnect the 50 VDC bias voltage source before taking the insulation resistance measurements. Electrical connections to specimens shall be made such that the bias and test voltages are of the same polarity. Insulation resistance shall be read as specified in 5.7.1.4. Apply 100 VDC on the specimens test points with the resistance meter and take the reading after one minute with the patterns under test conditions.

5.7.2.2 For qualification testing, measure and record resistance once every 24 hours (if insulation resistance quality measurements are required, see 5.7.3.1), between the 2nd and 3rd hour of the high termperature phase of each cycle. These measurements are to be conducted without opening the chamber. After completion of the temperature cycling, disconnect the bias voltage, remove the specimens from the chamber, and measure and record insulation resistance after the specimen has been at ambient conditions for more than one hour but less than two hours.

5.7.2.3 For conformance testing using pattern C, the measurements should be taken after disconnectng the bias voltage, removing the specimens from the test chamber and allowing the specimens to stabilize to laboratory ambient conditions for one hour and not exceeding two hours. See 6.2.

5.7.3 Class H Evaluation

5.7.3.1 Each test specimen shall be evaluated for insulation resistance quality following and/or during the stated conditions. Although several insulation resistance readings may be taken during the test, only the final (18th cycle) readings in high temperature phase in the chamber and the reading taken outside the chamber shall be used to determine pass/fail criteria. **Other readings are optional and may be used for diagnostic information or aborting the test.**

5.7.3.2 After completion of all electrical testing, the test specimens shall be examined for blisters or delamination following the 24-hour stabilization at ambient laboratory conditions. See 6.2.

5.8 Class T Procedures

5.8.1 Class T Testing

5.8.1.1 Condition the specimens at 50 ± 2 °C [122 ± 3.6 °F] with no added humidity, for a period of 24 hours.

5.8.1.2 Remove the specimens from the oven and cool to laboratory ambient temperature. Apply 100 VDC to comb patterns E and F of each test specimen. See 6.2.

5.8.1.3 The test points for qualification are at each pair of terminals (finger tabs) on the E and F comb patterns. One of the test points is connected to the negative terminal and the other to the positive terminal. For quality conformance, the pair of test points is 1 to 2 on the C pattern. One side of the C pattern should be connected to the negative terminal and the other side to the positive.

5.8.1.4 Place the specimens in the test chamber in the vertical position and under a condensation drip shield.

NOTE: Each chamber load shall contain at least one uncoated board that is representative of the cleaning process used prior to solder mask application for each solder mask tested.

5.8.1.5 Close the chamber door and bring the chamber to 65 ± 2 °C [149 ± 3.6 °F] and 90% relative humidity.

5.8.1.6 Allow specimens to stabilize at test conditions for 24 hours.

5.8.2 Class T Measurement

5.8.2.1 Connect the resistance meter to the appropriate test points. For qualification testing, one of the test points of the two terminal E and F patterns are connected to the negative terminal and the other test point to the positive. For quality conformance testing, one side of the C pattern (''Y'' pattern) should be connected to the negative terminal and the other side to the positive.

5.8.2.2 Apply 100 VDC on the specimens test points with the resistance meter and take the reading after one minute with the patterns under test conditions.

5.8.3 Class T Evaluation

5.8.3.1 Three separate sets of measurements are to be recorded for the uncoated specimen, the 'as received' specimen, and the specimen after solder exposure. Each set of readings shall be averaged and shall be greater than the minimum listed in the relevant specification. No individual insulation resistance (IR) value may be less than 0.1 x IR_{min}, where IR_{min} is the minimum in the set of IR values measured. Two measurements may be excluded from calculating the average if there is an assignable cause of low insulation resistance that can be attributable to the laminate itself or to the process used to produce the board. Such assignable causes include but are not limited to:

a. Contamination of the insulating surface of the board such as lint, solder splines, or water droplets from the conditioning chamber.

b. Incompletely etched patterns that decrease the insulating space between conductors by more than the amount allowed in the appropriate design requirements drawing.

c. Scratched, cracked or obviously damaged insulation between conductors.

5.8.3.2 The average insulation resistance (IRavg) is calculated from:

$$IR_{avg} = 10^{\left[\frac{1}{N}\sum_{1}^{N} \log IR_i\right]}$$

Where:

N = Number of test points (12 nominal)
IR_i = Individual insulation resistance measurements.

5.8.3.3 After completion of all electrical testing and following the nominal 24-hour stabilization at laboratory ambient temperatures (see 5.8.1.6), the test specimens shall be examined for mealing, blisters, delamination or other forms of degradation.

6 Notes

6.1 Initial wire placement must be maintained to ensure reproducible results.

6.2 Specimens may be stabilized at ambient conditions specified, inside the chamber.