



IPC-TM-650 TEST METHODS MANUAL

1 Scope This test method provides a means to assess the propensity for surface electrochemical migration. This test method can be used to assess soldering materials and/or processes.

2 Applicable Documents

2.1 IPC

IPC-B-25 Multipurpose Test Board

IPC-B-25A Multipurpose Test Board

IPC-6012A Qualification and Performance Specification for Rigid Printed Boards

IPC-9201 Surface Insulation Resistance Handbook

2.1 American Society for Testing and Materials (ASTM)

ASTM D-257-93 Standard Test Methods for DC Resistance or Conductance of Insulating Materials

3 Test Specimens IPC-B-25 (B or E pattern) or IPC-B-25A (D pattern) test boards shall be used, with conductor line widths and spacings of 0.318 mm [0.01250 in]. The method of manufacture should provide optimized conductor edge definition (refer to the Class 2 and 3 conductor width requirements in IPC-6012). The finished test boards should be untreated, bare copper, unless another surface finish is part of the evaluation. Figure 1 shows the IPC-B-25A test board; the D pattern is identical to the IPC-B-25 B or E pattern. For process evaluation, the test pattern board should be made using the same substrate material as will be used in practice to duplicate actual working conditions.

4 Equipment/Apparatus

4.1 Test Chamber A temperature/humidity chamber capable of producing an environment of 40°C ± 2°C [104 ± 3.6°F], 93% ± 2% RH, 65°C ± 2°C [149 ± 3.6°F], 88.5% ± 3.5% RH, or 85°C ± 2°C [185 ± 3.6°F], 88.5% ± 3.5% RH and allowing test boards to be electrically biased and measured without being opened under these temperature and humidity conditions is used.

4.2 Measuring Equipment High resistance measuring equipment, equivalent to that described in ASTM D-257-93,

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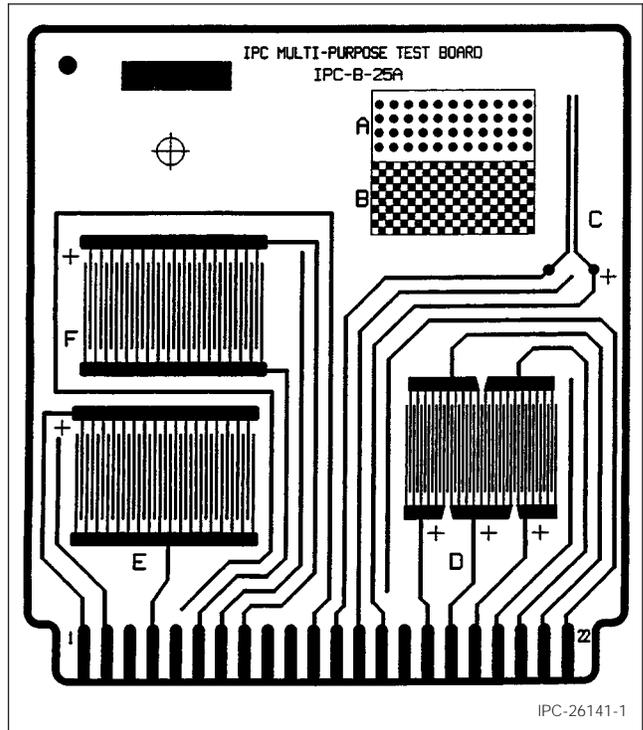


Figure 1 IPC-B-25A Test Board

with a range up to 10¹²ohm and capable of yielding an accuracy of ± 5% at 10¹⁰ohm with an applied potential of 100 VDC (10% tolerance); standard resistors should be used for routine calibration.

4.3 Power Supply Equipment capable of providing 10 VDC at 100 µA, with a 10% tolerance, shall be used.

4.4 Current-Limiting Resistors Use one 10⁶ ohm resistor in each current path. This equates to three current-limiting resistors for each 5-point comb pattern. Note that some test equipment has the current limiting resistors built into the testing system.

4.5 Connecting Wire Use PTFE-insulated, solid-conductor, copper wire, or equivalent. (See IPC-9201 Surface Insulation Resistance Handbook.)

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4.6 Other Dedicated Fixtures Hardwiring is the default connection method. Other dedicated fixtures may be used, provided that the fixture does not change the resistance for more than 0.1 decade compared to a comparable hardwired system, when measured at the test conditions.

5 Procedure

5.1 Test Specimen Preparation

5.1.1 In performing a material qualification (e.g., flux), all specimens are to be cleaned and dried using a process capable of yielding a **minimum** insulation resistance value of 4×10^{10} ohm when tested at 35°C, 85% minimum RH after 24 hours. If this test is being performed as a process qualification, additional pre-test processing is not allowed.

5.1.2 A minimum of three test specimens cleaned per 5.1.1 shall be used for controls.

5.1.3 For liquid flux:

Apply the liquid flux to the entire surface of the test specimen by brushing liberal quantities of the flux onto the specimen, by floating the specimen comb side down on the liquid flux, or by dipping the specimen into the flux. The specimen shall be drained vertically for one minute with the fingers of the comb pattern vertical. Alternatively, flux may be applied by production application processes - spray, foam, or wave. The edge connector fingers should be protected from flux.

It is recommended that production wave soldering equipment be used for soldering the test specimens, with a preheat profile representative of production. A solder fountain may be used (not a solder pot), with a residence time similar to the residence time in a solder wave. Solder composition is usually 60% tin \pm 5%, remainder is lead; for such alloys, the solder temperature shall be 250°C \pm 6°C [482 \pm 10.8°F]. For alloys other than those with compositions near the tin-lead eutectic, the solder temperature will be compatible with the usual soldering temperature for the alloy used.

If any solder bridging occurs, that specimen shall be discarded. A minimum of three specimens from the sample group shall be tested.

5.1.4 For solder paste:

A squeegee or screen printer shall be used with a stencil imaged with the test pattern. It should be noted that the Telcordia GR-78 pattern requires a minimum stencil thickness of

0.20 mm [7.9 mil]. Due to the fact that the minimum stencil thickness is often dependent on the pitch or trace width and spacing, a smaller stencil thickness may be used for fine features and shall be agreed upon between the tester and customer for the purpose of this test method.

Reflow the printed specimens using convection, infrared, or vapor phase reflow equipment using a reflow profile representative of production. Equivalent methods may be used if such equipment is not available.

If any solder bridging occurs, that specimen shall be discarded. The edge connector fingers should be protected from paste.

A minimum of three specimens from the sample group shall be tested.

5.1.5 For flux-cored wires:

Using a hand soldering iron and the cored wire under test, carefully apply solder to the fingers of all comb patterns. The edge connector fingers should be protected from flux.

If any solder bridging occurs, that specimen shall be discarded.

A minimum of three specimens from the sample group shall be tested. Each circuit path will be tested for the presence of solder shorts using a resistance meter (e.g. digital multimeter).

5.1.6 Post solder cleaning shall be performed only when such cleaning is part of the production process used in the final assembly.

5.1.7 When evaluating incoming board quality and/or final finishes, test specimens shall be used as received or as specified by the end user.

5.1.8 Attach test leads to the land areas of all patterns either by mechanical pressure (e.g., edge connectors, spring-loaded pins) or by hand soldering using Rosin (R) cored wire, using a shield to protect the test patterns from flux contamination during soldering; the flux shall not spread into the pattern area. Do not remove the flux.

5.2 Test Procedure

5.2.1 Place the terminated test specimens in a suitable rack that maintains the specimens at least 2.5 cm apart and such that the air flow is parallel to the direction of the test specimens in the chamber. For hardwiring, wires should be

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dressed from the bottom to prevent flux residues from the wire attachment from flowing onto the test patterns. With mechanical fixtures, fixtures should be to the side. Insert the limiting resistors in terminating leads 1, 3, and 5 of each pattern.

5.2.2 Place the rack approximately in the center of the test chamber. Route the wires to the outside of the chamber; dress the wiring away from the test patterns. Ensure that drops of condensation cannot fall on the specimens.

5.2.3 Close the chamber and allow all samples to stabilize for 96 hours at the specific temperature and humidity. After the 96-hour stabilization period, the initial insulation resistance measurements shall be made using voltage in the range of 45 VDC to 100 VDC. Due to polarity, measurements should be made between terminals 1 and 2, 3 and 2, 3 and 4, and 5 and 4, at the specific temperature and humidity with the current limiting resistors placed in series with the test circuit. Terminals 2 and 4 shall be at one potential, and terminals 1, 3, and 5 at the opposite potential.

5.2.4 Connect the samples to the power supply with the current limiting resistors placed in series with the test circuit, and apply 10 VDC for the duration of the test. The test polarity shall be the same as the measurement polarity used in section 5.2.3.

5.2.5 After 500 hours of applied bias (596 hours total), disconnect the power supply and repeat the measurements per 5.2.3 with the specimens under test conditions.

5.3 Data Handling The average (geometric mean) insulation resistance (IR_{avg}) is calculated from:

$$IR_{avg} = 10 \left[\frac{1}{N} \sum_1^N \log IR_i \right]$$

where,

N = number of test points (10 minimum),

IR_i = individual insulation resistance measurements

Where an assignable cause of low insulation resistance, which is properly attributable to the materials of construction or to

the process used to produce the test board, can be found, then such a value can be excluded from calculating the average.

Such assignable causes include:

- Contamination on the insulating surface of the board, such as debris, solder splints, or water droplets from the conditioning chamber
- Incompletely etched patterns that decrease the insulating space between conductors by an amount greater than that allowed in the appropriate design requirements drawing
- Scratched, cracked, or obviously damaged insulation between conductors

A minimum of 10 test measurements is required for the test to be valid.

5.4 Visual Examination After completion of the test, the test specimens shall be removed from the test chamber and examined, with back-lighting, at 10x magnification for evidence of electrochemical migration (filament growth), discoloration, and corrosion.

Note: Localized electrochemical migration on one comb may be caused by a testing anomaly.

6 Notes

6.1 Reference Documents

6.1.1 IPC-TR-476A Electrochemical Migration: Electrically Induced Failures in Printed Wiring Assemblies

6.1.2 IPC-9201 Surface Insulation Resistance Handbook

6.1.3 Telcordia GR-78-CORE

6.2 Specification of Test Conditions Users of this test method will need to specify one (1) of the three (3) temperature/humidity conditions called out in section 4.1. Note that IPC-TR-476A recommends using 65°C, 85% RH.