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# IPC-TM-650 TEST METHODS MANUAL

## 1 Scope and Purpose

**1.1 Scope** This method subjects unpopulated test specimens (samples) to sudden, extreme changes in temperature in order to evaluate the quality of interconnects formed during the manufacturing processes.

**1.2 Purpose** This method **shall** be used to simulate the thermodynamic effects of extreme temperature variations. The use of this method is intended to be able to capture “infant mortality” types of manufacturing defects.

**1.2.1** This method may provide for qualification, quality conformance testing and lot acceptance.

## 2 Applicable Documents

**IPC-T-50** Terms and Definitions

**IPC-2221** Generic Standard on Printed Board Design

**IPC-A-600** Acceptability of Printed Boards

**IPC-1601** Standard for Printed Board Handling and Storage

**IPC-4101** Specification for Base Materials for Rigid and Multilayer Printed Boards

**IPC-4103** Specification for Base Materials for High Speed/High Frequency Applications

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

**IPC-6013** Qualification and Performance Specification for Flexible Printed Boards

**IPC-6018** Qualification and Performance Specification for High Frequency (Microwave) Printed Boards

**IPC-9241** Guidelines for Microsection Preparation

**IPC-TM-650** Test Methods Manual<sup>1</sup>

2.1.1 Microsectioning - Microsectioning, Manual and Semi or Automatic Method

2.6.27 Assembly Simulation - Thermal Stress, Convection Reflow Assembly Simulation

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|--------------------------------------------------------------------------------------|----------------------|
| Number<br><b>2.6.7.2</b>                                                             |                      |
| Subject<br><b>Thermal Shock, Thermal Cycle and Continuity</b>                        |                      |
| Date<br><b>3/2020</b>                                                                | Revision<br><b>C</b> |
| Originating Task Group<br><b>Thermal Stress Test Methodology Subcommittee (D-32)</b> |                      |

## 3 Terms and Definitions

**3.1 Thermal Shock (Unpopulated Printed Board)** A temperature cycle with a change rate of 1 °C or more per second as measured on the surface of the test specimen, for at least the center 60% of each transition, during the heating and cooling portions.

**3.2 Thermal Cycle (Unpopulated Printed Board)** A temperature cycle that has a sample change rate of less than 1 °C per second as measured on the surface of the test specimen, for at least the center 60% of each transition, during the heating and cooling portions. While no minimum temperature change rate is specified, a change rate of at least 10 °C per minute is expected for qualification testing.

## 4 Test Specimen

### 4.1 Design/Construction Criteria

**4.1.1** The test specimen **shall** be the D coupon in accordance with the requirements of IPC-2221 Appendix A, or alternate coupon(s) AABUS.

**4.1.2** The test specimen(s) **shall** be constructed with holes contained in the printed board it represents as follows:

- Through holes: D coupons **shall** be constructed with both the largest plated-through holes (PTHs) and the smallest plated-through vias.
- Propagated structures: D coupons **shall** be constructed with and represent all applicable blind, buried, or filled through hole (propagated) via structures as defined in IPC-2221 Appendix A. D coupons contain two nets (structures). Multiple D coupons are used for designs with more than two structures.

**4.1.2.1** The test specimen(s) **shall** contain the representative ground and power planes of the printed board design.

**4.1.3** The test specimen(s) **shall** allow for microsection evaluation of all the applicable, representative PTHs and vias defined in 4.1.2 after exposure to the conditions of this Test Method. IPC-9241 provides guidance on the proper preparation of a metallographic sample (microsection) of a printed board.

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| IPC-TM-650               |                                                               |                       |
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| Number<br><b>2.6.7.2</b> | Subject<br><b>Thermal Shock, Thermal Cycle and Continuity</b> | Date<br><b>3/2020</b> |
| Revision<br><b>C</b>     |                                                               |                       |

**4.1.4** Deviations to the test specimen design/construction or use of an alternate test specimen **shall** be AABUS.

## 5 Apparatus

**5.1 Drying Oven** The oven **shall** be capable of maintaining a uniform set temperature within the 105 to 125 °C range.

### 5.2 Environmental Test Chamber

**5.2.1 Dual Chamber Option** An automatically controlled dual temperature environmental test chamber or other apparatus capable of maintaining the upper and lower temperatures.

**5.2.2 Single Chamber Option** An automatically controlled environmental test chamber or other apparatus capable of maintaining the upper and lower temperatures.

**5.2.3** The system **shall** have adequate environmental controls to maintain the tolerance range and limits listed in 6.5.1.3.

**5.2.4** The system should accommodate verifiable calibration compliance. See note 7.1 for additional considerations.

**5.2.5** Deviations to the equipment requirements and acceptability of the alternative methods **shall** be AABUS.

**5.3 Microscope** The magnification used for defect recognition **shall** be in agreement with the inspection requirements/capabilities defined in the applicable performance specification (e.g., IPC-6012, IPC-6013, IPC-6018, etc.) and the IPC-A-600 visual workmanship standard.

### 5.4 Resistance Measurements

**5.4.1** The resistance measurement **shall** have enough precision to clearly determine the resistance percent change as required by the user for the resistance level of each test specimen's nets.

**5.4.2** The total system uncertainty from resistance, temperature and time/cycle variations **shall** be less than 10% of the failure criteria required by the user. For example, if the required failure criteria is 5% then the total system uncertainty **shall** be no greater than 0.50%.

**5.4.3** The resistance measurement system **shall** be capable of recording resistances at least once per cycle, at or near the end of the peak temperature dwell, after the coupon has reached temperature stabilization.

## 5.5 Temperature Measurements

**5.5.1** The temperature measurement system should be capable of recording temperatures at least once per second throughout a complete cycle for both a representative test specimen and the heating/cooling medium. The system **shall** be capable of demonstrating the change rate defined in 3.1 and 3.2 and documenting a representative cycle.

## 6 Procedure

### 6.1 Conditioning

**6.1.1** The test specimen(s) **shall** be conditioned by drying in an oven to remove moisture for a minimum of six (6) hours at 105 to 125 °C. This conditioning process is mandatory if this method is used for qualification purposes.

This method **shall** replicate the assembly process. The requirement for conditioning (bake/drying) **shall** be in accordance with product/process lot Quality Conformance criteria. If conditioning of the printed board is not part of the normal assembly process, and this method is being used for quality conformance testing, then conditioning is not a requirement.

**6.1.2** Test specimens that are thicker or more complex may require longer baking times to achieve acceptable moisture levels. Record the bake times and temperature if different than those stated in 6.1.1. See IPC-1602 for additional guidance on baking to achieve acceptable moisture levels.

**6.1.3** Deviations to the conditioning requirements in 6.1.1 such as when used for quality conformance criteria and/or any changes to the time and temperature **shall** be AABUS.

### 6.2 Reflow Simulation

**6.2.1** The test specimen(s) **shall** be subjected to six (6) reflow simulation cycles in accordance with IPC-TM-650, Method 2.6.27 prior to Thermal Shock or Thermal Cycling.

**6.2.2** The reflow profile **shall** be in accordance with IPC-TM-650, Method 2.6.27, as specified.

**6.2.3** Other profiles or reflow simulation testing for other than 6 cycles are AABUS.

**6.3 Interconnect Resistance Measurements** Interconnect resistance measurements **shall** be taken at the following times:

- Prior to the test (initial ambient after reflow simulation).