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IPC-TM-650 TEST METHODS MANUAL

1 Scope and Purpose

1.1 Scope This method is intended to simulate exposure to the thermal conditions by convection reflow assembly.

1.2 Purpose This method **shall** be used to replicate the thermodynamic effects by assembly on the test specimen. The use of this method is intended to simulate those effects that are the result of soldering thermal excursions.

1.2.1 This method **shall** be used for qualification testing of an applicable test specimen. The evaluation of acceptability for qualification **shall** be in accordance with the requirements defined in 5.3.

1.2.2 This method may be used for lot acceptance. The evaluation for lot acceptability should be in accordance with the requirements defined in 5.3 or as agreed upon between user and supplier (AABUS).

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 Printed Board Handling and Storage Guidelines

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-9631 User's Guide for IPC-TM-650, Method 2.6.27

IPC-TM-650 Test Methods Manual¹

2.1.1 Microsectioning – Microsectioning, Manual and Semi or Automatic Method

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Subject Thermal Stress, Convection Reflow Assembly Simulation	
Date 2/2020	Revision B
Originating Task Group Thermal Stress Test Methodology Subcommittee (D-32)	

3 Test Specimen

3.1 Design/Construction Criteria

3.1.1 The test specimen **shall** be the A/B, AB-R, and/or the D coupon as designed in accordance with the requirements of IPC-2221 Appendix A or B. Use of alternate specimens **shall** be AABUS.

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

- A/B, A/B-R and D coupons **shall** be constructed with both the largest plated through-holes (PTHs) and the smallest vias.
- Propagated B and D coupons **shall** be constructed with the intended via structure. (Multiple B and D coupons are used for designs with multiple structures.)

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

3.1.2.2 The test specimen(s) **shall** contain the representative filled through vias, applicable blind and/or buried vias, including microvias, of the printed board design.

3.1.3 The test specimen(s) **shall** allow for microsection evaluation of all the applicable, representative PTHs and vias defined in 3.1.2 after exposure to the conditions of this Test Method.

Note: Special tooling may be required for potting an entire "D" Coupon for microsection examination.

3.1.4 Deviations to the test specimen design/construction or use of an alternate test specimen such as the printed board or a section of the printed board **shall** be AABUS.

4 Apparatus

4.1 Drying Oven

4.1.1 The oven **shall** be capable of maintaining a uniform set temperature within the 105 to 125 °C [221 to 257 °F] range.

¹. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/test-methods.aspx).

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4.2 Convection Reflow Oven or Simulator

4.2.1 The system used to simulate the thermodynamic effects of assembly **shall** be convection reflow.

4.2.1.1 The system **shall** have adequate environmental controls to maintain the tolerance range and limits in accordance with the reflow profile depicted in either Figure 5-1, Figure 5-2 or Figure 5-3.

4.2.1.2 The system should accommodate verifiable calibration compliance and reflow profile generation. See note 6.1 for additional considerations.

4.2.1.3 The test specimen **shall** be handled and stored in a controlled environment to minimize moisture ingress. See IPC-1601 for details on the proper handling and storage of test specimens.

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

4.3 Microscope

4.3.1 The magnification used for defect recognition must be in agreement with the inspection requirements/capabilities defined in the applicable performance specification (e.g., IPC-6012, IPC-6013, IPC-6018, etc.) and IPC-A-600.

4.4 Resistance Measurements of IPC-2221 Appendix A, D Coupons

4.4.1 When specified by performance specification or procurement documentation, resistance measurements of the IPC-2221B Appendix A, D coupons **shall** be required.

4.4.2 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 sample's nets.

4.4.3 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%.

4.4.4 The resistance data **shall** consist of at least 1 reading per sample net every second during the entire reflow cycle.

5 Procedure

5.1 Conditioning

5.1.1 The test specimen **shall** be conditioned by drying in an oven to remove moisture for a minimum of six (6) hours at 105 to 125 °C [221 to 257 °F].

5.1.2 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 5.1.1. See IPC-1601 for additional guidance on baking to achieve acceptable moisture levels. See note 6.2.

5.1.3 Deviations to the conditioning requirements in 5.1.1 such as when used for acceptance criteria and/or any changes to the time and temperature **shall** be AABUS. See 6.3.

5.2 Reflow Profile

5.2.1 Reflow the test specimen in accordance with Table 5-1 (default), Table 5-2 (low temperature profile) or Table 5-3.

5.2.2 The reflow profile **shall** be in accordance with either Figure 5-1, Figure 5-2 or Figure 5-3. Figure 5-1 represents the default reflow profile. Figure 5-2 represents the low temperature profile. Figure 5-3 represents a 245 °C reflow profile. The times to t1, t2 and t3 may vary based on the mass of the sample test specimen. To avoid over stressing of samples, times should be shortened for low mass samples. Times should be extended for high mass samples, such that the zone (air) temperature **shall not** be more than 25 °C above the target surface temperature at any point in the cycle.

The attachment of thermocouples to the sample test specimen **shall** be such that the reflow profile is calibrated to the surface temperature of the test specimen.

5.2.3 The test specimen **shall** be subjected to a minimum of six (6) reflow cycles.

5.2.4 The cool down rate **shall** be in accordance with Table 5-1, Table 5-2 or Table 5-3, based on the reflow profile selected in 5.2.1. The cool down is complete when the test specimen reaches 45 °C. The test specimen **shall** achieve a thermal equilibrium of 45 °C or less prior to starting the next reflow cycle. If the time it takes to achieve thermal equilibrium cannot be determined, then a five (5) minute dwell between reflow cycles **shall** be required.

5.2.5 Deviations to the reflow profile or number of cycles **shall** be AABUS.

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Table 5-1 260 °C Nominal Reflow Profile Specifications (Default)*

Value	Time (Seconds)	Temperature (°C)	Description
t1	210 ± 15	–	Target preheat time
t2	270 ± 10	–	Target peak reflow time
t3	330 ± 15	–	Target cool-down start time
t3 - t1	120 ± 30	–	Target time above T1
T1	–	230	Maximum preheat temperature
T2	–	260 ± 5	Target reflow temperature
Point	Time (Seconds)	Temperature (°C)	Description
A	0	30	Upper specification limit values
B	100	230	
C	195	230	
D	255	265	
E	285	265	
F	345	230	
G	550	30	
H	30	30	Lower specification limit values
I	157	93	
J	225	230	
K	260	255	
L	280	255	
M	315	230	
N	383	30	
Segment	Slope (°C / second)		Description
A-B & I-J	2.0		Maximum preheat rate
H-I	0.5		Minimum preheat rate
F-G	-1.0		Minimum cool-down rate
M-N	-3.0		Maximum cool-down rate