The Institute for Interconnecting and Packaging Electronic Circuits
2215 Sanders Road • Northbrook, IL 60062-6135

IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.39	
Subject	
Dimensional Stability, Glass Reinforced Thin Laminates	
Date	Revision
2/86	**A**
Originating Task Group	
N/A	

1.0 Scope This procedure defines a test method used to determine dimensional stability of glass reinforced, copper-clad, thin laminates intended for use in rigid multilayer printed boards.

The test is appropriate for checking material consistency. It is not intended for defining suitability of the raw material to be used in a specific printed board product or process.

2.0 Applicable Documents

IPC-TR-483 ''Dimensional Stability Testing of Thin Laminates''

3.0 Test Specimen The specimen shall be 300 mm x 280 mm [12 in x 11 in] in size with the warp direction in the 300 mm dimension. A minimum of three specimens is required per inspection lot. When evaluating laminate sheets, specimens should be taken from opposite diagonal corners and from the center of the sheet. For precut panels three randomly selected panels shall be used to obtain the test specimens.

4.0 Apparatus

4.1 The measurement apparatus shall be capable of measuring the specimen within an accuracy of 0.0125 mm [0.0005 in], over 250 mm [10.0 in] dimension. (Supergauge, or equivalent, may be used.)

4.2 Ovens used for baking must be of the air circulating type and capable of ± 2°C control. The recovery time of the temperature must be less than 15 minutes after specimens are placed in the oven.

4.3 A stabilization chamber (drying cabinet) containing calcium chloride or silica gel capable of maintaining less than 20 RH at 21 ± 2°C.

5.0 Test Procedure

5.1 Preparation of the Specimen

5.1.1 Mark the specimen for traceability in the identification area (see Figure 1). No mechanical or chemical pre-cleaning is permitted on the specimen.

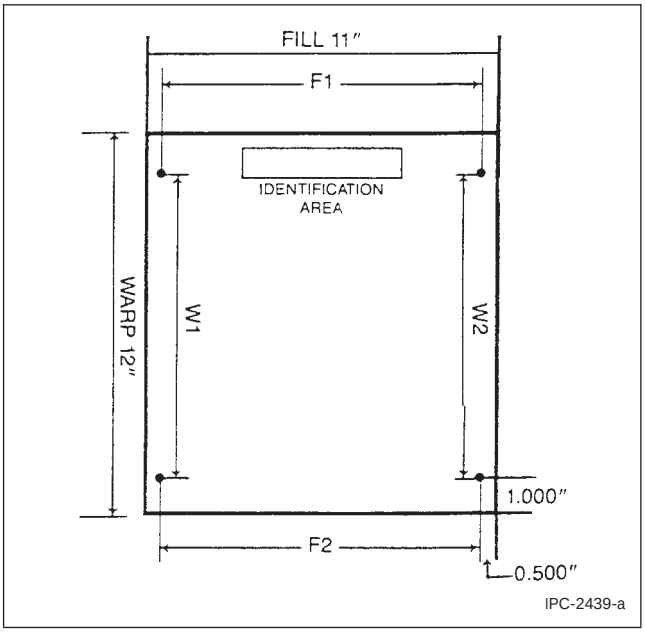

Figure 1 All dimensions are in inches. Four measurements are required as indicated. Locate measuring points approximately 12.7mm [0.500 in] from each edge in the fill direction, and 25.4 mm [1.00 in] from each edge in the warp direction.

5.1.2 Prepare the four location points (see Figure 1) by drilling or scribing.

5.1.3 Measure distances Fl, F2, W1, and W2 utilizing the apparatus defined in paragraph 4.1. Define distances to the nearest 2.5 microns [0.0001 in]; the last digit of the reading may be estimated. Record all values as initial measurements.

5.1.3.1 If optical measurement must be used, a rigid plate shall maintain the test specimen in a flat and horizontal position.

5.1.4 Place a 12 mm [0.5 in] diameter tape dot over holes or scribe marks on side of laminate to be measured and a piece of 25 mm x 12 mm [1.0 in x 0.5 in] wide tape over identifying information.

5.2 Copper Removal Remove copper by etching in cupric chloride containing spray etcher at less than 50°C (122°F). Rack samples upon exit from etcher, rinse, remove the tape, and air-dry laminate. Submit to bake cycle (paragraph 5.3) within four hours. (*Note:* Do not use resist stripping solutions.)

5.3 If only the thermal stress cycle is to be used proceed to 5.5. If not, proceed to 5.4.

5.4 Bake Cycle

5.4.1 Bake specimens at 105°C ± 5°C for four hours ± 10 minutes. Vertically rack and place specimens in oven parallel to air flow with specimens being separated by a minimum of 1/2 inch.

5.4.2 After baking, immediately place the test specimens in a stabilization chamber (paragraph 4.3).

5.4.3 Remove from stabilization chamber after one hour +½/-0 hours and, within 5 minutes, measure $W1_1$, $W2_1$, $F1_1$, and $F2_1$, using the apparatus defined in paragraph 4.1.

5.4.4 If the thermal stress cycle is to be included in this test, proceed to paragraph 5.5. If not, proceed to 5.6.

5.5 Thermal Stress Cycle After the bake cycle measurement (5.4), if immediate further processing is not feasible, place specimens in a stabilization chamber until test is continued.

5.5.1 If a stabilization chamber is used, remove from the stabilization chamber and bake specimens at 150°C ± 5°C for two hours ± 5 minutes. Vertically rack and place specimens in oven parallel to air flow, with specimens being separated by a minimum of 1/2 in.

5.5.2 After baking, immediately place the test specimen in a stabilization chamber (paragraph 4.3).

5.5.3 Remove from stabilization chamber after 1 hour + 1/ 2 hour, -0 hours, and, within 5 minutes, measure W1, W2, F1, and F2, using the apparatus indicated in paragraph 4.1. Record values as $W1_2$, $W2_2$, $F1_2$, and $F2_2$.

5.6 Evaluation Determine the change in dimensional stability using the following formulation:

5.6.1 Warp Evaluations

$$\text{Warp} = \frac{W1_1 - W1}{W1} \times 10^3 = \text{Mils/per inch for W1 after bake}$$

$$\frac{W2_1 - W2}{W2} \times 10^3 = \text{Mils/per inch for W2 after bake}$$

Repeat for $W1_2$ and $W2_2$ for after stress

Where W1/W2 = initial dimensions,
$W1_1/W2_1$ = after bake dimensions, and
$W1_2/W2_2$ = after thermal stress.

5.6.2 Fill Evaluations

$$\text{Fill} = \frac{F1_1 - F1}{F1} \times 10^3 = \text{Mils/per inch for F1 after bake}$$

$$\frac{F2_1 - F2}{F2} \times 10^3 = \text{Mils/per inch for F2 after bake}$$

Repeat for $F1_2$ and $F2_2$ for after stress

Where F1/F2 = initial dimensions,
$F1_1/F2_1$ = after bake dimensions, and
$F1_2/F2_2$ = after thermal stress.

5.6.3 Calculations Take the warp dimensions made on all the measured specimens and determine the mean value for the warp dimensional stability characteristics of the laminate after bake. Follow similar procedures on the calculations for the fill dimensional stability characteristics after bake. Extreme values should be eliminated using the procedure defined in paragraph 5.6.4. Similar measurements are made to calculate the after thermal stress dimensional stability characteristics.

5.6.4 Extreme Value Eliminated Take measurements in subgroup (warp or fill) and arrange in descending order of magnitude. Solve for D, using procedure detailed in Table 1. If calculated D is larger than the value of D shown in Table 2 for the number of measurements being evaluated, the outlier is significant and should be deleted.

6.0 *Notes* The following is a checklist that should be used by personnel responsible for performing this method in order to provide repeatable/correlatable results. The IPC Dimensional Stability Task Group responsible for the technical report on dimensional stability has determined that checklist items 2, 5, 6, 9, 14, 15, 16 and 18 are critical to appropriate use of this procedure. (See IPC-TR-463.)

Table 1 Calculation Procedure

Subgroup Size	*If Apparent Outlier is Largest Value*	*If Apparent Outlier is Smallest Value*
n = 3-7	$D = \frac{\text{Largest Value} - \text{2nd Largest Value}}{\text{Largest Value} - \text{Smallest Value}}$	$D = \frac{\text{2nd Smallest Value} - \text{Smallest Value}}{\text{Largest Value} - \text{Smallest Value}}$
n = 8-10	$D = \frac{\text{Largest Value} - \text{2nd Largest Value}}{\text{Largest Value} - \text{2nd Smallest Value}}$	$D = \frac{\text{2nd Smallest Value} - \text{Smallest Value}}{\text{2nd Largest Value} - \text{Smallest Value}}$

Table 2 Extreme Value Table

n	*D (Confidence Level 95%)*
3	0.941
4	0.765
5	0.642
6	0.560
7	0.507
8	0.554
9	0.512
10	0.433

CHECKLIST

1. Is the specimen size 300 mm x 280 mm [12 in x 11 in]? ____
2. Is the warp direction properly identified? ____
3. Were the four location points prepared by either drilling or scribing? ____
4. Were the measured points located approximately 12 mm [0.5 in] from each edge of the fill direction and approximately 25 mm [1.0 in] from each edge of the warp direction? ____
5. Were the measurements taken from the same feature location, i.e., edge of the hole, center, scribe mark, etc? ____
6. Were specimens processed without mechanical or chemical pre-cleaning? ____
7. Was cupric chloride etching with spray used to remove the copper? ____
8. Was the temperature of the etching less than 50°C? ____
9. The specimens were not exposed to resist stripping solution? ____
10. Were specimens racked after removal from etching cycle? ____
11. Is the oven used for baking capable of ± 2°C control and has a recovery time of less than 15 minutes? ____
12. Were specimens subjected to the bake cycle within 4 hours after etching? ____
13. Were the specimens baked at 105°C ± 5°C for 4 hours and vertically racked? ____
14. Was the stabilization chamber capable of maintaining 20% RH maximum at 21 ± 2°C? ____
15. Was each specimen removed from stabilization after 1 hour + 1/2 hour -0 hours and were all measurements taken within 5 minutes? ____
16. Were samples stored in stabilization chamber between after bake and after thermal stress measurements if immediate processing not feasible? ____
17. Were specimens thermal stressed at 150°C ± 5°C for two hours and vertically racked? ____
18. Was each specimen removed from stabilization after 1 hour + 1/2 hour -0 hours and were all measurements taken within 5 minutes? ____

Note: When using the above checklist, all answers should be affirmative. The technician performing the test should sign the report, record the date and times of all actions taken, and report any deviations on the procedure.