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 Lami-
nates"

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 mea-
suring 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 tem-
perature must be less than 15 minutes after specimens are
placed in the oven.

4.3 A stabilization chamber (drying cabinet) containing cal-
cium 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.

5.1.2 Prepare the four location points (see Figure 1) by drill-
ing or scribing.

5.1.3 Measure distances F1, 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 posi-
tion.

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 iden-
tifying 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 ±1/2 hours and, within 5 minutes, measure \( W1, W2, F1, \) and \( F2 \), 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 \( W1, W2, F1, \) and \( F2 \).

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

### 5.6.1 Warp Evaluations

\[
\text{Warp} = \frac{W11 - W1}{W1} \times 10^3 = \text{Mils/}\text{inch for } W1 \text{ after bake}
\]

\[
\frac{W21 - W2}{W2} \times 10^3 = \text{Mils/}\text{inch for } W2 \text{ after bake}
\]

Repeat for \( W1 \) and \( W2 \) for after stress

Where \( W1/W2 = \text{initial dimensions}, \]
\( W1/W2 = \text{after bake dimensions, and} \]
\( W1/W2 = \text{after thermal stress}. \]

### 5.6.2 Fill Evaluations

\[
\text{Fill} = \frac{F11 - F1}{F1} \times 10^3 = \text{Mils/}\text{inch for } F1 \text{ after bake}
\]

\[
\frac{F21 - F2}{F2} \times 10^3 = \text{Mils/}\text{inch for } F2 \text{ after bake}
\]

Repeat for \( F1 \) and \( F2 \) for after stress

Where \( F1/F2 = \text{initial dimensions}, \]
\( F1/F2 = \text{after bake dimensions, and} \]
\( F1/F2 = \text{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.)
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.

Table 1 Calculation Procedure

<table>
<thead>
<tr>
<th>Subgroup Size</th>
<th>If Apparent Outlier is Largest Value</th>
<th>If Apparent Outlier is Smallest Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 3-7</td>
<td>(D = \frac{\text{Largest Value} - \text{2nd Largest Value}}{\text{Largest Value} - \text{Smallest Value}})</td>
<td>(D = \frac{\text{2nd Smallest Value} - \text{Smallest Value}}{\text{Largest Value} - \text{Smallest Value}})</td>
</tr>
<tr>
<td>n = 8-10</td>
<td>(D = \frac{\text{Largest Value} - \text{2nd Largest Value}}{\text{Largest Value} - \text{2nd Smallest Value}})</td>
<td>(D = \frac{\text{2nd Smallest Value} - \text{Smallest Value}}{\text{2nd Largest Value} - \text{Smallest Value}})</td>
</tr>
</tbody>
</table>

Table 2 Extreme Value Table

<table>
<thead>
<tr>
<th>n</th>
<th>D (Confidence Level 95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.941</td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>5</td>
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<td>6</td>
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<td>7</td>
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<td>8</td>
<td>0.554</td>
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<tr>
<td>9</td>
<td>0.512</td>
</tr>
<tr>
<td>10</td>
<td>0.433</td>
</tr>
</tbody>
</table>