



# IPC-TM-650 TEST METHODS MANUAL

**1 Scope** This procedure is an alternate method for preparing multiple metallographic specimen(s) using microsection equipment. The specimen(s) is(are) for evaluation for quality of the laminate system, plated-through holes (PTHs), the copper foils, platings, and/or coatings. The same basic procedure may be used for examination of other areas on the product.

**Note:** This microsection technique is a process and not a test method.

**Note:** SAFETY The use of the materials listed in Section 4 may be limited or forbidden in some environments. Please review the Material Safety Data Sheet (MSDS) for the materials being used.

## 2 Applicable Documents

**IPC-MS-810** Guidelines for Semi-Automatic Microsection

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

**3 Test Specimens** Remove the required specimen(s) from the product to be tested. Allow sufficient clearance to prevent damage to the area and PTHs to be examined. The recommended clearance from the pad edge to the cut surface is 2.54 mm [0.100 in]. Abrasive cut-off wheels can cut closer to the sample without damaging the area to be examined.

## 4 Apparatus

**4.1** Sample removal method (see IPC-MS-810 for best method).

**4.2** Sample alignment tools.

**4.3** Mount molds.

**4.4** Mounting surface.

**4.5** Vacuum/pressure system (optional).

**4.6** Release agent (optional).

**4.7** Potting material (recommended maximum cure temperature is 93 °C [200 °F]).

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Subject <b>Microsection—Semi or Automatic Technique Microsection Equipment (Alternate)</b>	
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Originating Task Group <b>Rigid Printed Board Performance Task Group (D-33a)</b>	

**4.8** Explosion proof fume hood for mounting material.

**4.9** Microsection equipment (see IPC-MS-810 for purchasing guidelines).

**4.10** Metricated abrasive paper P100–P1200 (American grit range: 100–600).

**4.11** Polishing cloths.

**4.12** Diamond abrasive (1.0 µm - 9.0 µm [39.4 µin - 354 µin]) or oxide abrasive (3.0 µm - 0.1 µm [118 µm - 3.94 µin]).

**4.13** Polishing lubricant.

**4.14** Micro-etch solution.

**4.15** Micro-etch applicator (optional).

**4.16** Engraver (optional).

## 5 Procedure and Evaluation

### 5.1 Procedure

**5.1.1** The semi or automatic microsection technique is a process and not a test method. Microsectioning needs to be viewed as a process with quality criteria as each major step is completed. This procedure specifies the quality criteria that must be met to make microsections that can consistently find the defects (or anomalies) of concern. The customer should not specify the process steps and materials but the quality criteria for surface preparation of the specimen.

**5.1.2 Preparation of Specimen(s)** Remove the specimen from the PCB or panel such that the tooling pin holes or target PTHs are not damaged. Complete any thermal testing required by the customer.

**5.1.3 Inspect Tooling Pin System** Inspect the tooling pin holes or slots to verify they are not plugged or damaged. Clear plugged tooling pin holes with a tool that will not change its dimensional location or enlarge the hole. A drill bit of the same hole diameter is recommended.

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Inspect the tooling pins for foreign material adhering to them. Clean the pin surface as required. Discard any pins that are bent or the surface scarred.

**5.1.4 Load Specimen On Tooling Pins** The pins align the target PTHs on a common plane. This common plane assures all the PTHs will grind to the center of the hole at the same instance.

Push the tooling pins into the tooling holes or slots. The pins must fit snugly.

**5.1.5 Potting the Specimen(s)** The potting material must have a low shrink rate, and the cure temperature must be less than 93 °C [200 °F] at the center of the mount to prevent false failures. Mold release may be applied to the mount to permit easy removal of the cured mounting material (optional). Thoroughly mix the potting material without trapping air and pour into the mold. Assure the tooling pins do not shift position or rise up while pouring and/or curing of the potting material. If necessary to avoid voids in the finished mount and to insure adequate hole filling, evacuate the mount before cure using a vacuum system. Allow the potting material to cure and return to ambient temperature before removing from the mount. Remove the hardened mounts from their molds (as applicable).

**5.1.6 Traceability** The mount/specimen must be permanently marked in such a manner to ensure traceability back to the PCB or panel. If the mounts are cured within the mount holder, traceability is not required until the mounts are removed from the holder.

**5.1.7 Mount Quality** The minimum qualities the mount must exhibit are no gaps between the potting material and the specimen, the PTHs filled with material, and no bubbles in the potting material in the areas of examination.

#### 5.1.8 Grind Process Set-Up

**5.1.8.1 Tooling Stops** The mount holder has tooling stops to allow the equipment to grind a set distance. These stops must be calibrated for each abrasive paper grit to assure the scratches from the previous step are removed. See IPC-MS-810 for a detailed discussion and examples.

**5.1.8.2 Grind Pressure** The equipment's pressure setting is the direct force on a load cell. To determine the pressure on each mount, divide the pressure setting by the surface area of

the mounts being processed. See IPC-MS-810 for a detailed discussion and examples.

The recommended pressure setting for six mounts at 38.1 mm [1.5 in] diameter is 351.5 g/sq. cm (5.0 psi) with the wheel RPMs between 300–600.

**5.1.8.3 Other Variables** Recommended variables to be familiar with are length of time the abrasive paper removes material efficiently, scratch size the abrasive paper causes on the specimen(s) surface, and water quality (undissolved particles that can cause scratches; i.e., calcium deposits).

**5.1.9 Grind the Mounts** Be liberal with the amount of water used to promote efficient removal of material by the abrasive paper. The hardness of the specimen will dictate the number of rough and fine grind steps needed to reach near the center of the hole. The rough grind grits P180-P240 (American 180-240) are used to enter the edge of the PTH, and the fine grind grits P800-P1200 (American 400-600) are used to grind near the center of the hole. The distance to stop short of the center is determined by the scratch size of the last grind step used.

A recommended grinding process from which to start development is:

	Step 1	Step 2	Step 3
Abrasive grit size	P180	P 400(opt)	P1000
RPM	200–300	200–300	200–300
Pressure (g/sq.cm)	351.5	351.5	351.5
Time	15 seconds after the stops touch		

**5.1.9.1 Clean the Mounts** Clean the mount surface with a mild hand soap to remove the abrasive grit. This is especially important when the same mount holder is used for grinding and polishing. Be careful not to scratch the surfaces to be evaluated while cleaning.

**5.1.10 Grind Quality** The minimum qualities the mount must exhibit are:

- 1) The target PTHs are ground to the center of the PTHs as defined by the customer's specification.
- 2) Only fine grind scratches apparent on the mount when viewed at 100X magnification.
- 3) No gap between the potting material and the specimen(s).
- 4) No residual abrasive paper grit material on the mount surface.

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5) The ground surface has only one plane of material removal. If the mount has several planes of material removal, portions of the sample will not polish since the odd surface never touches the polishing cloth.

**5.1.11 Polish Process Setup** The tooling stops are recessed or removed from the mount holder during polishing. The reason is the polish process removes a negligible amount of material and will not change the flatness of the surface. The number of polish steps is determined by the hardness of the specimen(s), distance to the center of the hole, and scratch size of the last fine grind step. There may be multiple intermediate polish steps but only one final polish step.

**5.1.12 Intermediate Polish Steps** The intermediate steps must remove the fine grind scratches and prepare the surface for the final polish step. The recommended process settings for six mounts at 38.1 mm [1.5 in] diameter is less than 351.5 g/sq. cm (5.0 psi), a medium to hard polish cloth, short nap surface, and low wheel RPM (100–200). Additional variables that must be considered are volume of lubricant, lubricant types, abrasive size, abrasive type (diamond or oxide), and process time.

A recommended polish process from which to start development is:

	Step 1	Step 2	Step 3
Type of cloth	Napless	Napless	Nap
Type of polish abrasive	Diamond	Diamond	Diamond
Polish abrasive size	6.0 µm [236 µin]	1.0 µm [39.4 µin]	1.0 µm [39.4 µin]
Time	—	—	30 sec max.
Pressure (g/sq. cm)	351.5 or less	351.5 or less	351.5 or less

**5.1.12.1 Clean the Mount(s)** The mounts must be cleaned between each polish step. The reason is to prevent contaminating the next polish step with the current grit size. If the polish step is contaminated, the step will produce undesirable scratches. Clean the mounts with mild hand soap, rinse with water, and dry. Do not scratch the surface to be evaluated when cleaning.

**5.1.13 Final Polish the Mounts** The final polish step removes the scratches from intermediate polishing and prepares the surface for evaluation. The recommended process

setting for the same surface areas as 5.1.12 are a medium to soft polish cloth, low wheel RPM (100-200), and low pressure setting 351.5 g/sq. cm (5.0 psi) or less. Additional variables that must be considered are volume of lubricant, type of nap surface on polish cloth, and process times. The type of abrasive used must be diamond (maximum rated size: 1.0 µm [39.4 µin]) or colloidal silica.

#### Warning

If a high nap polish cloth is used too long in the final polish, the inspectors ability to see defects can be hampered. This step must be engineered for short process times (30 seconds or less) with a careful balance of lubricant to prevent copper rounding.

**5.1.13.1 Clean the Mount** This last clean step must remove all the contaminants as described in 5.1.12.1 and the polish lubricant. The lubricant film will prevent even microetching of the specimen(s).

**5.1.14 Traceability** If the mounts are cured in the mount holder, remove the mounts. The mount/specimen must be permanently marked in such a manner to ensure traceability back to the PCB or panel.

**5.1.15 Polish Quality** The surface qualities of a properly prepared microsection mount are:

1. The target PTHs are ground to the center of the PTH as defined by the customer's specifications.
2. No scratches larger than 1.0 µm [39.4 µm] on the metal surface to be examined (i.e., copper).
3. No smear of metals (i.e., copper, tin/lead, nickel) over other metals, board base material, and/or potting material.
4. No rounding of metal surfaces (i.e., copper) in the PTH.
5. No gaps between the specimen(s) and potting material.

Rounding of metal surfaces is apparent as the material edge being out of focus at 100X magnification on the metallograph or shaded a charcoal black color.

## 5.2 Evaluation Method

**5.2.1 Separation Evaluation** Evaluate the PTHs for inner-layer separation prior to microetch. Any observations need to be reinspected after etch. The separations noted in the unetched and microetched conditions will not necessarily correlate one to one.

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**5.2.2 Microetch the Specimen** Swab or dip the specimen into a suitable microetching solution and rinse with running water. The recommended etching solutions and formulations are listed in IPC-MS-810. The etch time will vary with the type of etchant chosen to microetch the sample.

**5.2.3 Evaluation** Evaluate the average thickness of the plated metals and determine PTH quality per the customer's specifications.

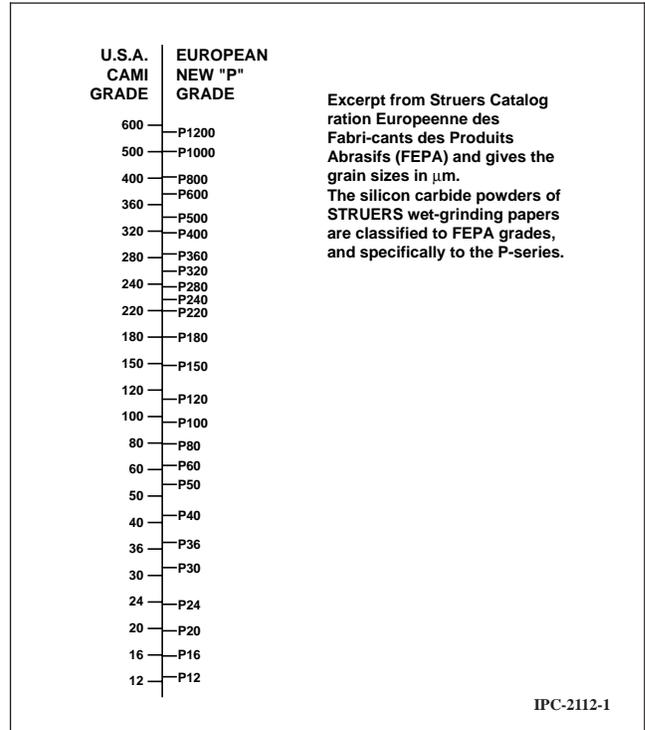
**6 Notes**

**6.1 Diamond Polish** The diamond polish media is preferred over alumina for PCBs being evaluated to IPC-6012 Class 2 and 3 products. Diamond media substantially reduces the risk of metal smear and rounding. Diamonds provide a sharper definition of copper surfaces to evaluate for separation of conductive surfaces.

**6.2 Etchants** The two most common microetchants for copper are ammonium hydroxide/hydrogen peroxide and sodium dichromate etchant. Both have benefits and drawbacks that must be considered when making a choice (see IPC-MS-810).

**6.3 Abrasive Paper** The abrasive grit size has different designators (Metricated versus American). Figure 1 tabulates the correlation between grades.

**6.4** See IPC-MS-810 for photomicrographs illustrating acceptable and unacceptable polish quality.



**Figure 1 Abrasive paper grit size (American vs. European)**