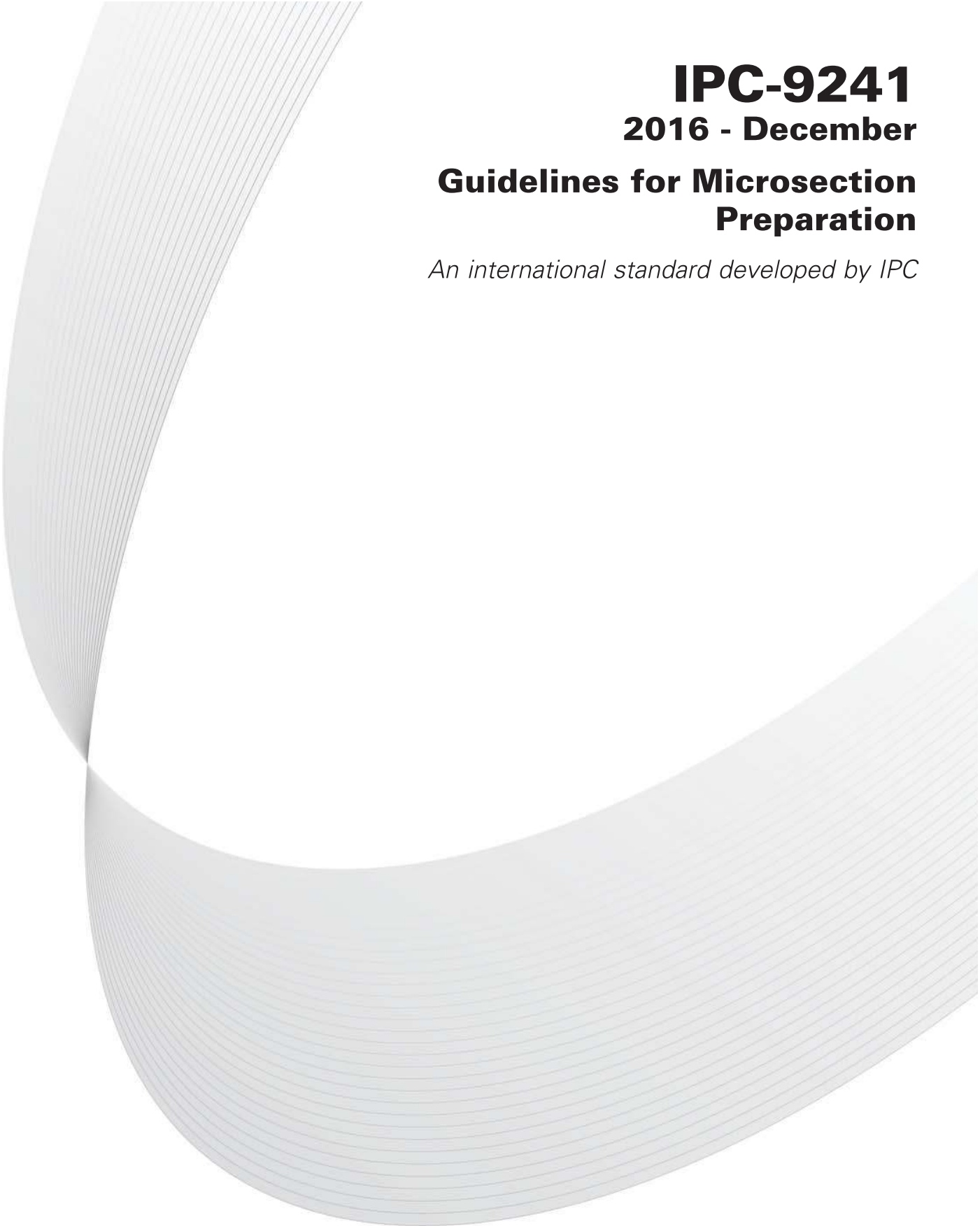




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2016 - December

Guidelines for Microsection Preparation

An international standard developed by IPC

Association Connecting Electronics Industries



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IPC-9241

Guidelines for Microsection Preparation

Developed by the Microsection Subcommittee (7-12) of the Testing Committee (7-10) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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Guidelines for Microsection Preparation

1 SCOPE

Microsection preparation is a process. These guidelines discuss the many variables and problems associated with the process from sample removal to micro-etch. The guidelines do not promote any one vendor's process, but discuss the variables common to microsectioning.

The process variables and problems are organized so the reader can research a specific issue or overview the variables of a process area.

2 APPLICABLE DOCUMENTS

2.1 IPC¹

IPC-2221 Generic Standard on Printed Board Design

IPC-2222 Sectional Design Standard for Rigid Organic Printed Boards

IPC-2223 Sectional Design Standard for Flexible Printed Boards

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-TM-650 Test Methods Manual²

2.1.1 Microsectioning, Manual and Semi or Automatic

2.2.5 Dimensional Inspections Using Microsections

3 SAMPLE REMOVAL PROCESS

3.1 Sample Location

3.1.1 Coupon Test Strip Companies generally use a "home grown" or military conformance coupon for microsection inspection. IPC-2221 outlines the attributes a coupon test strip should exhibit based on the product type being built.

Benefits:

- Production parts are not lost due to microsection testing.
- The internal and external features are the same from panel to panel to facilitate Statistical Process Control (SPC) data collection.
- The strips may be used to screen product as required.
- The customer can correlate to your microsection results easier because you both sample in the same location on the same test design.

Drawbacks:

- Space is lost on the panel that could be used to build parts.
- The test strip may not be representative of the associated part.

3.1.2 Part The actual production parts are used for microsection inspection.

Benefits:

- Space is not wasted on the panel due to test strips.
- There are no paneling constraints that dictate where the test strip must be placed to preserve part correlation.
- There is less of an issue over how representative the test strip is to the associated part.

1. www.ipc.org

2. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/html/testmethods.htm)

Drawbacks:

- Microsection inspection of parts may not be cost effective for product with a high unit cost.
- For multilayer printed boards, multiple samples are usually microsectioned to inspect all the inner layer connections for each panel. These multiple samples can significantly increase the sample plan.
- The test results may not agree with the customer's results because microsections were taken on different locations of the part. This can only be resolved by providing the part sample locations to the customer.

3.2 Removal Method Regardless of the method chosen, the cutting edge should remain a minimum of 0.25 cm [0.100 in] from the edge of the target plated-through-hole (PTH) pads. This is to prevent cutting deformation causing damage to the sample which may lead to false failures. The only exception to this guideline is abrasive cut-off wheels.

3.2.1 Punching This method removes the sample by using a die to punch the sample out of the panel. The die must be hollow so that it never comes in contact with the target PTHs. The force that pushes the die through the panel may be pneumatic or manual (kick or leverage) method. This method of sample removal is not recommended for brittle materials.

All cuts must be made with a fast, smooth, and strong motion. This requires periodic maintenance to keep the die sharp and the ram properly aligned and well oiled.

Benefits:

- This method quickly removes the sample.
- No route programs or cams are required to remove the sample.
- No pin-up holes are required to provide a reference point to remove the sample.

Drawbacks:

- The dies can quickly cause a great deal of damage to the test sample when not properly maintained. The sharpness of the die can be monitored by setting limits on how much crazing the edge of the sample is permitted. The recommended limit is no more than 0.025 cm [0.010 in] from the sample's edge at 10X magnification.
- This method is limited by the printed board thickness. The maximum printed board thickness this method is recommended for is 3.18 mm [0.125 in] using pneumatic system and 0.25 cm [0.100 in] using the manual method.
- Do not punch brittle material (i.e., polyimide). The shock damage will cause false defects to appear in the sample. The primary concern is laminate defects.

3.2.2 Sawing This method removes the sample using a jeweler's saw or miniature band saw.

3.2.3 Abrasive Cut-Off Wheels The sample is removed by a silicon carbide, aluminum oxide, or diamond rimmed blade. This method has the lowest opportunity for sample deformation but it also has the longest cycle time. This is the only method that can cut close (under the 0.25 cm [0.100 in] limitation) to the target PTH pads without damaging them.

Benefits:

- The method has the lowest sample deformation opportunity of all methods.
- There are no limitations on printed board thickness or material type the sample can be removed from.

Drawbacks:

- This method can be slow depending on wheel selecting and dressing.
- The saw can only cut in a straight line. This limitation may cut test strips in half causing traceability problems and/or require multiple runs to cut the sample to the desired size.
- The lubricant used to cool the saw adds an extra operation to the microsection process. The lubricant must be cleansed from the samples before bake or solder float depending on your microsection methodology. While there are diamond cut-off wheels that can be used without lubricant, the product may be too hot to handle with bare hands. This would be a process indicator that thermal damage may have occurred and an alternative method or process should be considered.

3.2.4 Routing This method uses a small milling machine or production routers used by the shop to remove the samples.

Benefits:

- The printed board thickness limitations are not as strict as some of the other methods.
- The method removes brittle samples while reducing mechanical damage.
- When using laboratory milling or routing machines, the set-up time can be shortened when always routing the same design of coupon from the panels. Only the alignment of the panel takes some time.

Drawbacks:

- The route operation setup time for each run can be lengthy. The router must be able to route multiple test strips (10 or more) within each run to be time efficient. The small milling machine and pin routers usually only route one test strip at a time.
- Reference zero for the route cam or program that controls the router bit are defined by pin-up holes. These pin-up holes are available when the sample is routed in panel form, PTHs within the part, or target PTHs in the test strip. If the target PTHs are used, care must be taken that no mechanical stresses are transferred to these holes during the route sequence.
- The route routine must not dwell in the same location too long. The router bit will generate a great deal of heat which will cause sample deformation. This becomes more critical as the printed board thickness increases. The patterns that generate the highest amount heat are square corners and tight radius turns.
- Beware that the vacuum system cannot swallow the samples. Precautions need to be taken to prevent this circumstance.

3.2.5 Pre-Routing The sample is routed leaving a finger tab that holds the sample in the panel. To remove the sample, the operator pushes or cuts the sample out of the panel by breaking the finger tab.

Benefits:

- The samples are routed and remain with the panel. This resolves panel traceability issues when the actual sample is not serialized.
- The samples, test strip, and parts are routed at one time. This prevents unnecessary use of costly production routers to only route the sample.
- The coupon can go through processing, and then be removed easily without an additional routing step to evaluate the process step.

Drawbacks:

- The finger tabs width needs to be optimized to keep the sample in the test strip during handling and permit an operator to push the sample out. The tab width may be different for families of products and/or printed board thickness. Thick printed boards may require needle nose pliers (or equivalent) to break the finger tabs. If the tab is too small, the coupon may be allowed to fall out unintentionally.
- Care must be taken to where the pivot point is located when using a tool to remove the sample to prevent mechanical stresses.
- The location of the tab needs to be as far from the target PTHs, microsection tooling holes, circuit features, and the production board as possible. This will minimize the likelihood that material stresses will be transferred to the sample when it is pushed out.
- Altering the design of the coupon to allow space for a pre-route, without routing through copper, may change the construction attributes (i.e., dielectric thicknesses) so that they are not reflective of the production printed board.

4 MOUNT PROCESS

The samples are mounted in a potting material. The mounts must exhibit certain characteristics for microsection process to be successful. These characteristics are:

- Holes to be microsectioned (Target Holes) must be in the same axis.
- One type of material potted in a mount.
- Potting material and sample material are of comparable hardness.
- No gaps or depressions in the potting material.

4.1 Sample Orientation

4.1.1 Same Product Type within A Mount The same product type should be within a mount. Mixing product types (i.e., MLB and flex) may cause portions of the mount to grind faster than others. When the unequal grinding is extreme, the mount will not have a flat surface. The portion that is not flat is highly susceptible to scratches during the polish process.

4.1.2 Samples Should Not Touch There should be a minimum spacing between the samples. The recommended distance is 0.025 to 0.157 cm [0.010 to 0.062 in]. This space allows the mounting material to support all the surface features of the samples and prevent false failures (i.e., lifted lands).

4.1.3 Sample Orientation The samples should be oriented in the mount so the first sample is easily distinguishable. This will enable the operator to use the chosen traceability system to report results. The samples may also be oriented so that layer one is in the same direction.

4.1.4 Traceability A system needs to be developed to trace each sample back to its associated panel and/or part. This requires traceability not only within the mount but also from mount to mount. Marking methods for the mount are external labels, embedded labels, mechanical scribing, and permanent ink markers. The type of label chosen must be compatible with lubricants, solvents, abrasive, and etchants that the mount is exposed to during processing.

The use of a 'standard' coupon pinning scheme, computer processing, or bar code labeling can be used as alternatives to the standard marking methods. A tremendous amount of time can be saved by using a well-documented and integrated traceability system.

4.2 Tooling System The tooling holes, tooling pins, and molds are the heart of the high volume microsection system. The tooling pins are placed in the tooling holes to align the target PTHs in the same axis. This alignment increases the likelihood the grinding process stops at the centerline of all the target PTHs at the same instance.

4.2.1 Holes Drilled at Drill Process

4.2.1.1 Misdrills Audit the location of the tooling holes with a template or X-Y coordinate machine. The audit should only be done when problems are suspected.

4.2.1.2 Sample Removal Damage There should be a minimum of 0.127 cm [0.050 in] of material between the tooling hole edge and the edge of the sample. This will prevent tooling hole damage that will allow the sample to move during the cure of the potting material.

4.2.1.3 Plugged Holes Inspect the tooling holes to ensure no solder or debris is plugging them. If the holes are plugged, remove the obstruction with a hand held drill bit. Do not use a tool that will enlarge or 'egg-shape' the tooling hole.

4.2.2 Tooling Pins

4.2.2.1 Pins Fit Tight The tooling pins must fit tight in the tooling holes. Any play in the holes will translate to the distance the grind process will miss the centerline of the target PTHs. A loose fit can also cause the samples to hang at an angle (planar distortion) instead of straight down. Planar distortion will cause an overestimation of the plating thickness which will be significantly increased when combined with the center of the hole tolerance. See Figure 4-1 and Figure 4-2.

4.2.2.1.1 The plane of microsection indicated in the x axis shown in Figure 4-2 should bisect the outer circle (which represents the drilled hole). It is understood that the microsection will never perfectly bisect the circle. Conformity of a microsection is defined such that the prepared microsection **shall** provide an apparent diameter that is greater than 90% of the true diameter. The region over which conformity is obtained is approximated by the green rectangle as shown in Figure 4-2.

4.2.2.1.2 A parameter of interest is the ratio of apparent plating thickness to true plating thickness, at the limit of microsection conformity. As the grinding and polishing accuracy of the microsection generates an apparent diameter that is less than 90% of the true hole diameter, the observable and apparent plating thickness continues to deviate from the true plating thickness within the microsection sample. Figure 4-3 provide a graphical illustration of the allowable error limits based on hole diameter and copper plating thickness.

4.2.2.2 Pin Positioning The pins should be of equal length on each side of the first sample and last sample. This helps to ensure the samples are mounted in the center of the mold. The samples should not be skewed to the side of the mount.

4.2.2.3 Flush to Mount Tooling Edge The tooling pins are placed on the mount mold edge or on pads attached to the grind mount holder (see Figure 4-4). The mount edge dimensions the distance from the centerline of the tooling holes to the target PTHs. A system **shall** be developed to assure the pins remain in contact with the edge during the mounting process. Some current methods are weights, metal clips and physical stops that hold the pins in place.

4.2.3 Mounting Molds

4.2.3.1 Sample Positioning The samples should not be skewed to one side of the mount. The minimum distance the sample should be from the mount edge is 2.54 mm [0.10 in]. Samples at or near the mount edge tend to grind/polish unevenly. Also, the sample external features are not supported to prevent false failures due to microsection damage.

4.2.3.2 Construction Permits Exothermal Reaction The potting material cures by an exothermal reaction. The mount **shall** be constructed of material that efficiently transfers heat from the curing potting material to the atmosphere. Recommended mold construction materials are stainless steel, aluminum, and plastics. If the mold insulates the exothermal reaction, the cure will take longer which may have an adverse effect on the mount material's hardness and increase the likelihood of false failures.

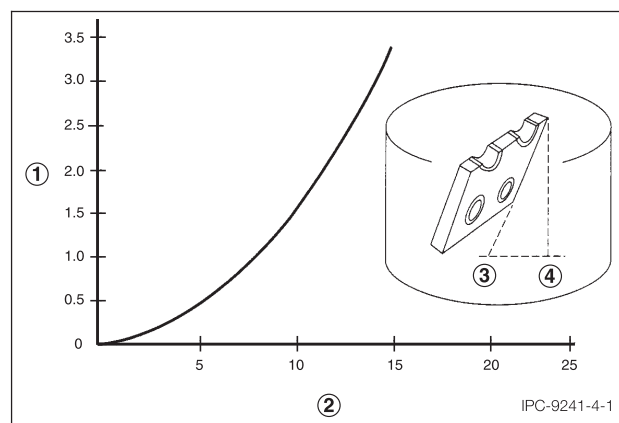


Figure 4-1 Planar Distortion

Note 1. Percent allowable error.

Note 2. Tilt angle - degrees.

Note 3. Actual.

Note 4. Ideal.

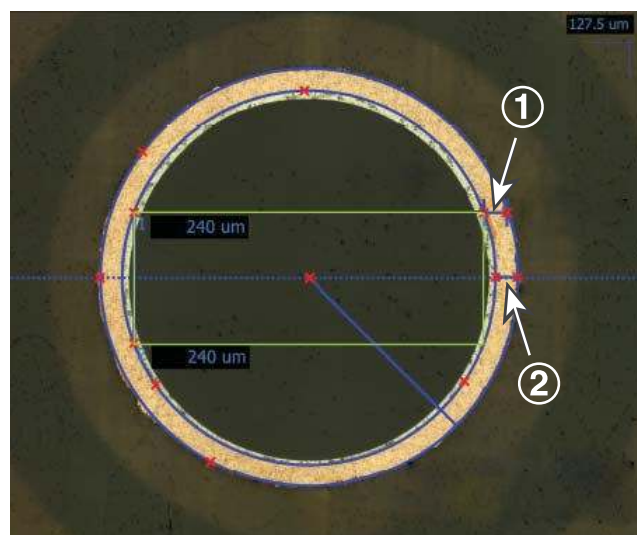


Figure 4-2 Center Line Integrity

Note 1. Apparent plating thickness = 85 μm [3,346 μin].

Note 2. Actual plating thickness = 80 μm [3,150 μin].

Note 3. Radius of plated hole = 691.1 μm [27,209 μin].

Note 4. Radius of drilled hole = 771.7 μm [30,382 μin].

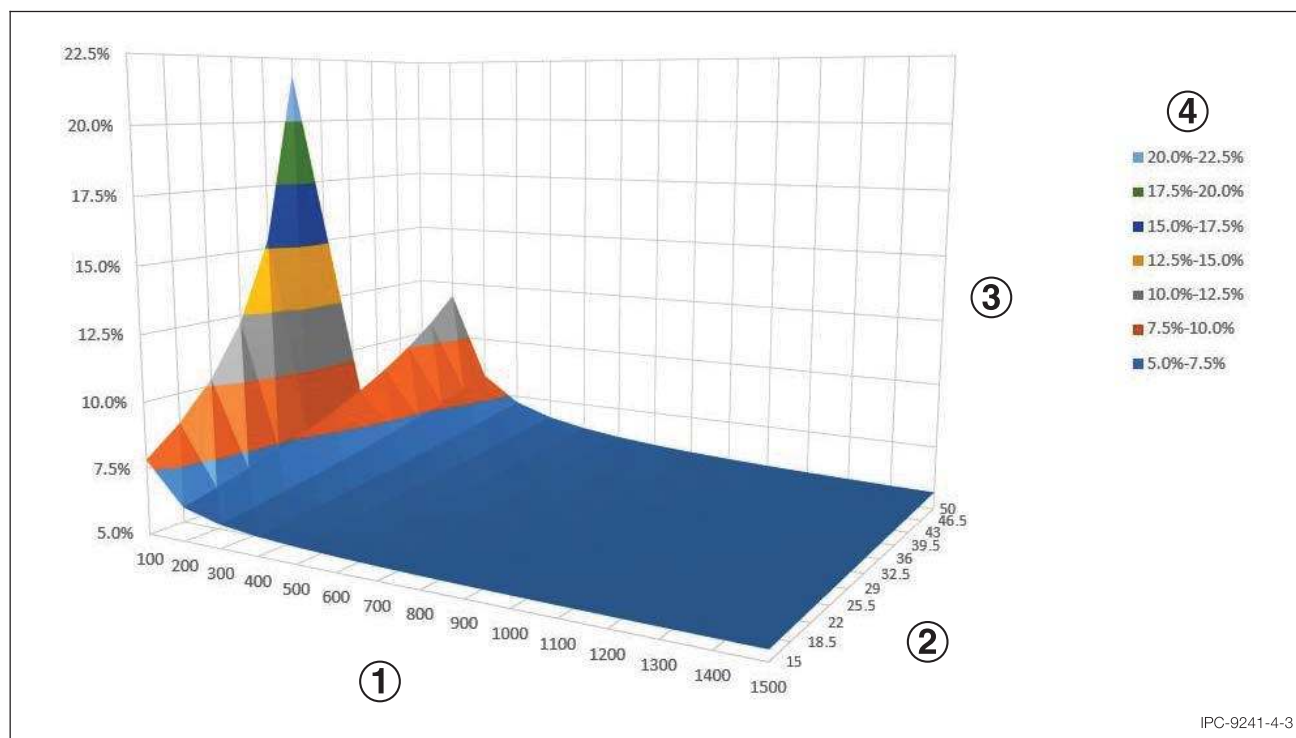


Figure 4-3 Center Line Error Estimation

Note 1. Hole diameter (μm).

Note 2. Plating thickness (μm).

Note 3. Percent error.

Note 4. Error percentage.

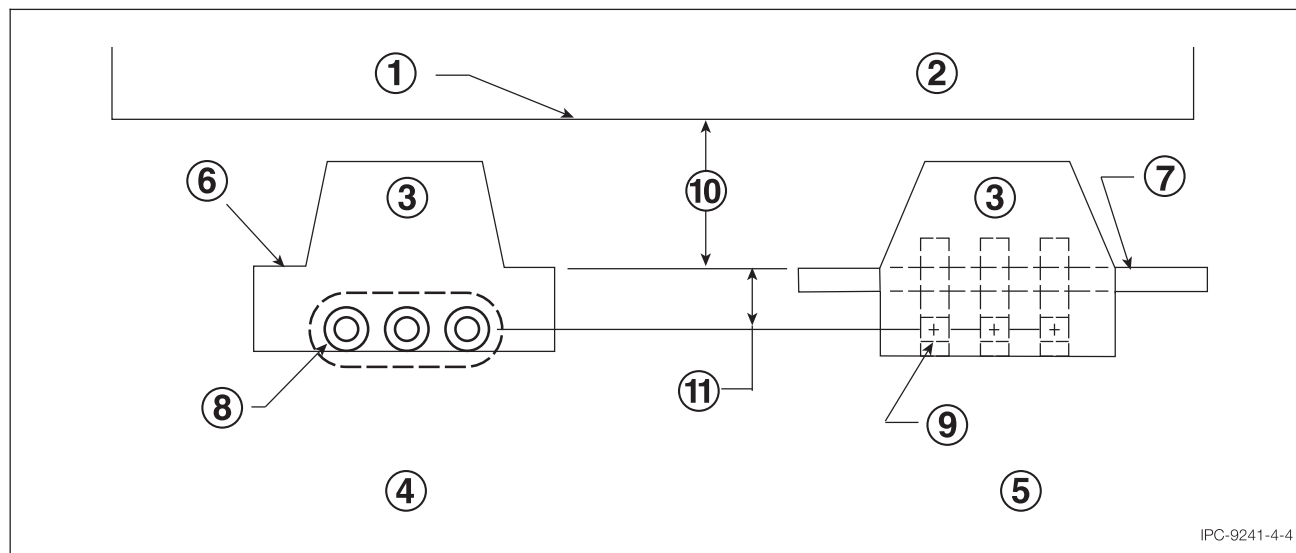


Figure 4-4 Reference Zero Relationship Between Target Holes and Tooling Edge

Note 1. Reference zero.

Note 2. Mount holder.

Note 3. Mount.

Note 4. Reference edge on mount.

Note 5. Reference edge on tooling pins.

Note 6. Reference edge.

Note 7. Tooling pins.

Note 8. Target PTHs.

Note 9. Target PTHs (side view).

Note 10. These surfaces must contact each other.

Note 11. Distance from tooling edge to centerline of target PTHs.