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IPC-6012 or IPC-A-600 Which Standard is Right One For Me

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IPC-6012

IPC-6012D
2015 - September

Qualification and Performance Specification for Rigid Printed Boards

Supersedes IPC-6012C
April 2010

A standard developed by IPC

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IPC-6012

Scope: This specification establishes and defines the qualification and performance requirements for the fabrication of rigid printed boards.

Purpose: The requirements apply to the following Technologies:

- Single side,
- Multilayer boards
- Active/passive embedded circuitry printed boards
- Metal core printed boards

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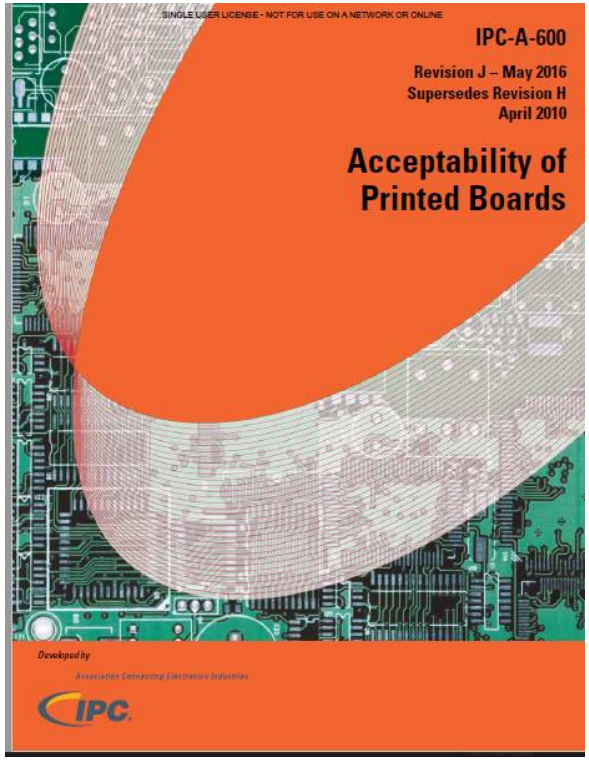

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IPC-A-600

SCOPE

- This document describes the target, acceptable, and nonconforming conditions that are either externally or internally observable on printed boards. It represents the visual interpretation of minimum requirements set forth in various printed board specifications, e.g.; IPC-6010 series, J-STD-003, etc.

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IPC-A-600

PURPOSE

- The visual illustrations in this document portray specific criteria of the requirements of current IPC specifications. In order to properly apply and use the content of this document, the printed board should comply with the design requirements of the applicable IPC-2220 series document and the performance requirements of the applicable IPC-6010 series document. In the event the printed board does not comply with these or equivalent requirements, then the acceptance criteria should be as agreed between user and supplier (AABUS).

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6012 and 600

- The differences:
- The 6012 is the specification and 600 is the visual representation of the 6012 document and they work hand in hand.

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6012 and 600

- 6012 is based on Performance Specifications and defines what information should be added to contractual agreements and contracts.
- Also defines Default requirements in the specific information if not in the contractual agreement
- Defines contamination requirements for solder bath system used for hot air leveling systems
- Provides the definitions used in the 600 for the CIS and CIT programs.

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6012 and 600

- Shows Final Finishes and Coating requirements

Table 3-3 Final Finish and Coating Requirements

Code	Finish	Thickness	Applicable Acceptability Specification	Marking Code[1]
S	Solder Coating over Bare Copper	Coverage & Solderable[2]	J-STD-003 J-STD-006	b0
b1	Lead-Free Solder Coating over Bare Copper	Coverage & Solderable[2]	J-STD-003 J-STD-006	b1
T	Electrodeposited Tin-Lead (fused) – minimum	Coverage & Solderable[2]	J-STD-003	b0
X	Either Type S or T	b0		
TLU	Electrodeposited Tin-Lead Unfused – minimum	8.0 µm [315 µin]	J-STD-003	b0

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6012 and 600

- Document also covers internal multilayer construction and restrictions and such
  - Whole table 3-9 dedicated to Minimum Annular ring.

Table 3-9 Minimum Annular Ring[1,2]

Characteristic	Class 1	Class 2	Class 3
EXTERNAL PTHs	Not greater than 180° breakout of hole from land when visually assessed. The land/conductor junction **shall not** be reduced below the allowable width reduction in 3.5.3.1.	Not greater than 90° breakout of hole from land when visually assessed. The land/conductor junction **shall not** be reduced below the allowable width reduction in 3.5.3.1. The conductor junction should never be less than 50 µm [1,969 µin] or the minimum line width, whichever is smaller.	The minimum annular ring **shall** be 50 µm [1,969 µin]. The minimum external annular ring may have 20% reduction of the minimum annular ring in isolated areas due to defects such as pits, dents, nicks, pinholes, or splay in the annular ring of isolated areas.

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3.6 Structural integrity

- This is one of the most important section of the 6012 document as it covers everything related to the fabrication of the physical board itself.

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6012 and 600

- The 6012 Document also defines 3.6 Structural Integrity requirements for the boards;
  - After stress testing Plated Hole Integrity after Stress
  - Delamination
  - Hole breakout
  - Plating thickness
  - Copper wrap plating
- This is based upon the use of coupons and all properties and requirements **shall** be performed on the thermally stressed test coupon or printed board and all requirement **shall** be met.

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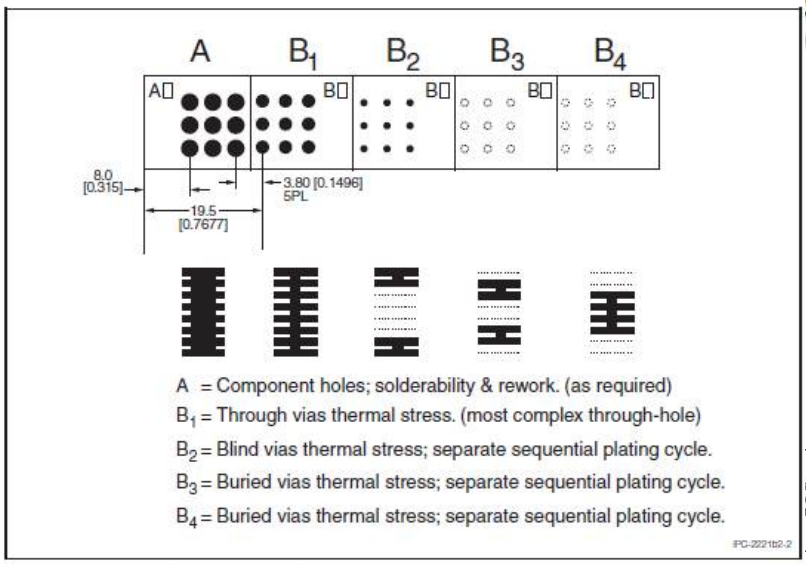

Figure B.2-2 Test Coupons A and B (Conductor Detail), mm [in]

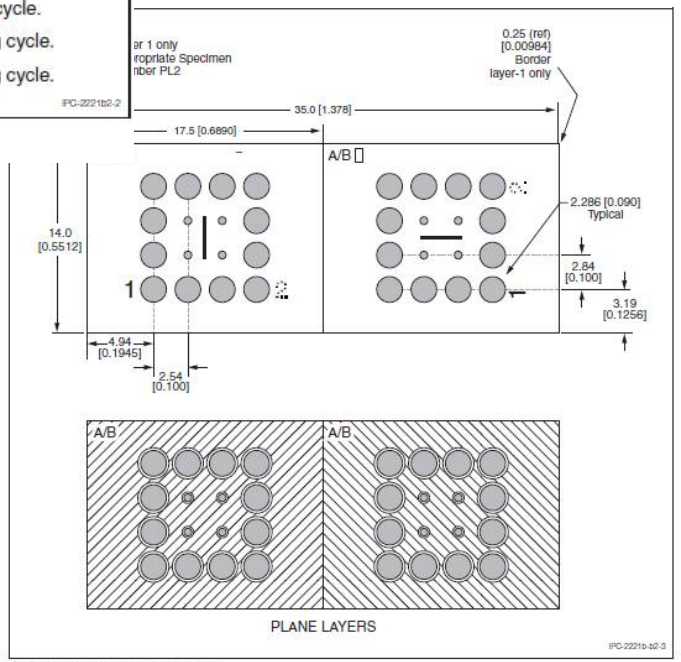

Figure B.2-3 Test Coupon A/B, mm [in]

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Plated Hole Integrity After Stress

Table 3-10 Plated Hole Integrity After Stress

Property	Class 1	Class 2	Class 3
Copper plating voids[2]	Three voids allowed per hole. Voids in the same plane are not allowed. No void **shall** be longer than 5% of printed board thickness. No circumferential voids greater than 90° allowed.	One void allowed per specimen provided the additional microsection criteria of 3.6.2.2 are met.	
Plating folds/inclusions	The minimum copper thickness in Table 3-4 through Table 3-6 **shall** be met. For positive etchback, measurements should follow the topography of the dielectric. When negative etchback results in folds in the copper plating, the copper thickness **shall** meet the minimum requirements as measured from the face of the internal layer as depicted in Figure 3-12. The negative etchback limits **shall** be in accordance with Figure 3-16.		
Burrs and nodules[2]	Allowed if minimum hole diameter is met.		
Glass fiber protrusion[2]	Allowed. See 3.6.2.11.		
Dielectric Removal (see Figure 3-15)	125 µm [4,921 µin] maximum wicking allowance plus maximum etchback or smear removal allowance	100 µm [3,937 µin] maximum wicking allowance plus maximum etchback or smear removal allowance	80 µm [3,150 µin] maximum wicking allowance plus maximum etchback or smear removal allowance
Innerlayer inclusions (inclusions at the interface between internal lands and through hole plating)	Allowed on only one side of hole wall at each land location on 20% of each available land.	None allowed.	
Internal foil cracks[1]	"C" cracks allowed on only one side of hole provided it does not extend through foil thickness.	None allowed.	

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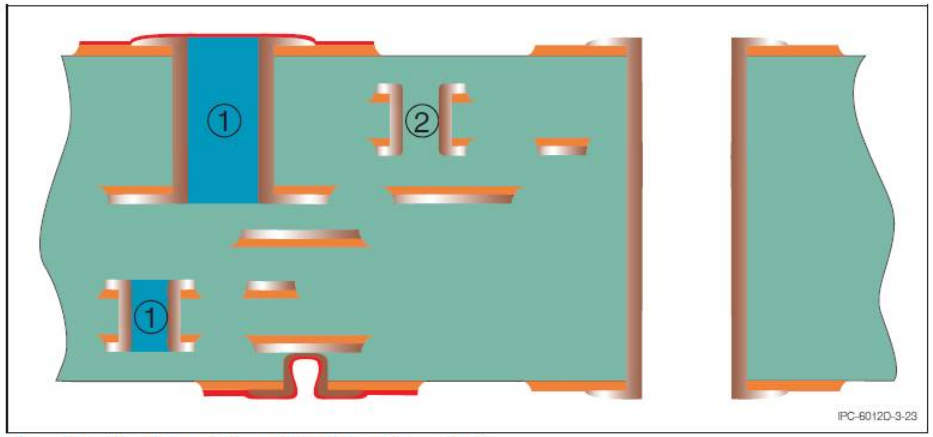

Figure 3-23 Wrap Copper in Type 4 Printed Board (Acceptable)
Note 1. Material Fill.
Note 2. Resin Fill.

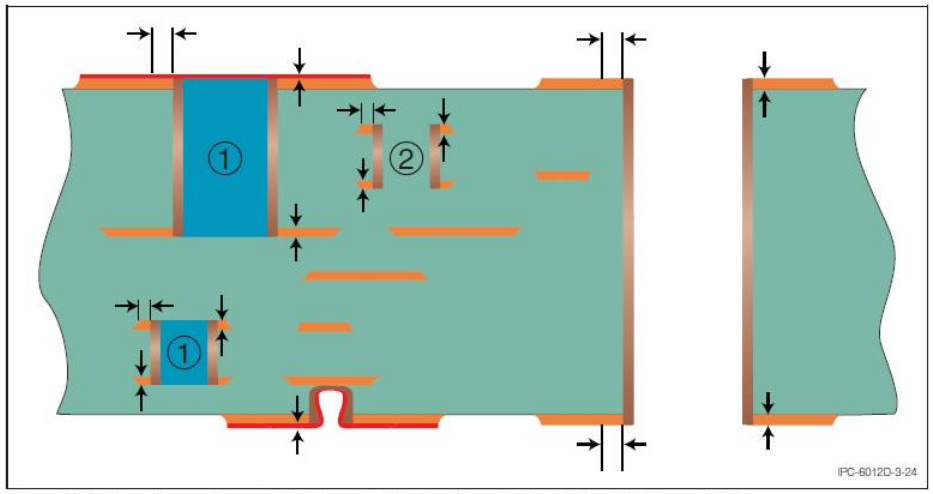

Figure 3-24 Wrap Copper Removed by Excessive Sanding/Planarization/Etching (Not Acceptable)
Note 1. Material Fill.
Note 2. Resin Fill.
Note 3. Dimension lines and arrows indicate where wrap copper has been removed.

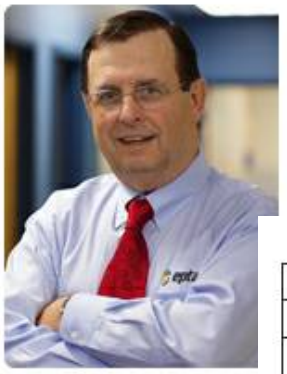

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Table 3-11 Cap Plating Requirements for Filled Holes

	Class 1	Class 2	Class 3
Copper Cap – Minimum Thickness	AABUS	5 µm [197 µin]	12 µm [472 µin]
Filled via Depression (Dimple) – Maximum[1]	AABUS	127 µm [5,000 µin]	76 µm [2,992 µin]
Filled Via Protrusion (Bump) – Maximum[1]	AABUS	50 µm [1,970 µin]	50 µm [1,970 µin]

Note 1: Does not apply to copper filled microvias.

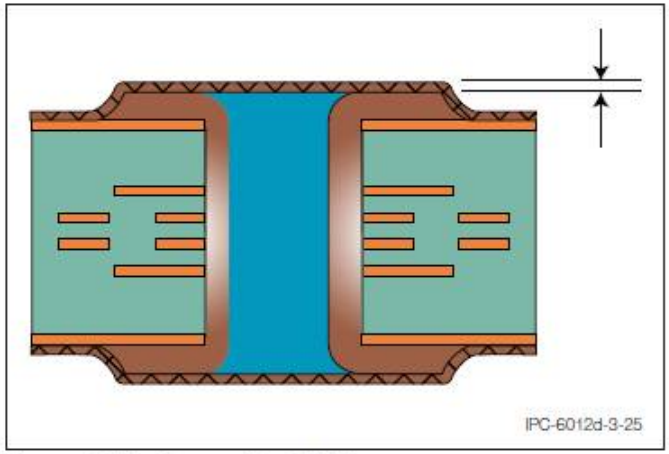

Figure 3-25 Copper Cap Thickness

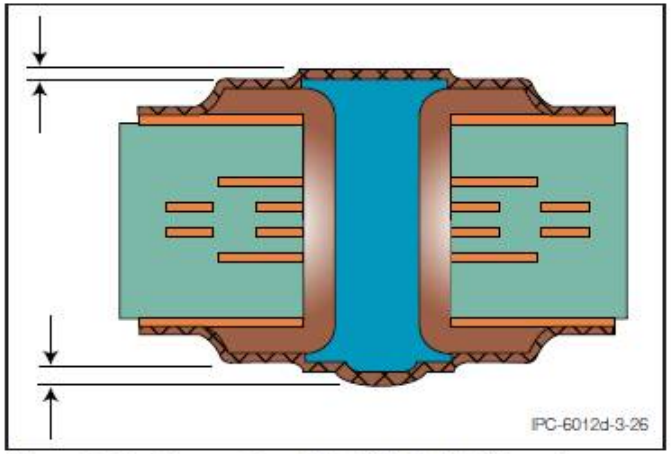

Figure 3-26 Copper Cap Filled Via Height (Bump)

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2.6 HOLES – PLATED-THROUGH – GENERAL

2.5.6 Cap Plating of Filled Holes – (Visual)

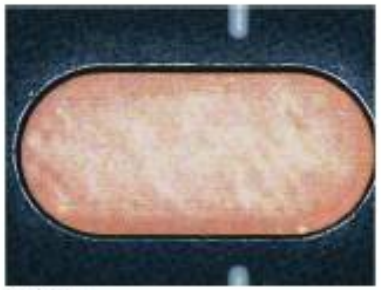

Figure 256a

Target Condition – Class 3, 2, 1

- Copper surface is planar with no indication of cap plating.

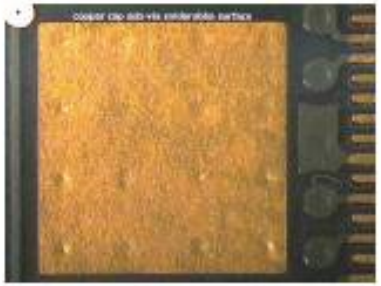

Figure 256b

Acceptable – Class 3, 2, 1

- When cap plating of the filled via is specified on the procurement documentation, the requirements of 2.7.1.1, 2.7.1.2, 2.7.1.3 and the requirements of the applicable performance specification for rectangular and round surface mount pads **shall** apply.
- No plating voids exposing the resin fill area, unless covered by solder mask.
- Visually discernable protrusions (bumps) and/or depressions (dimples) that meet the integrity requirements of the applicable performance specification.

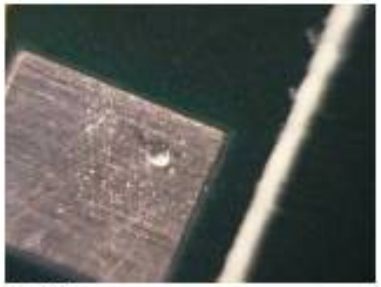

Figure 256c

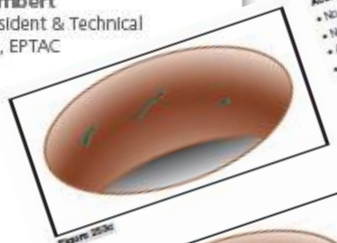

Figure 253c

Acceptable – Class 1

- No more than three voids in any hole.
- Not more than 10% of the holes have voids.
- Any void is not more than 10% of the hole length.
- All voids are less than 90° of the circumference.

Nonconforming – Class 3, 2, 1

- Defects either do not meet or exceed above criteria.

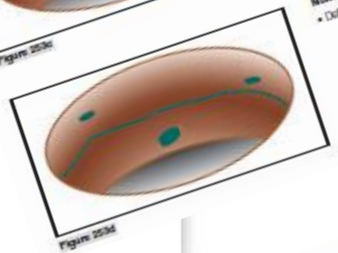

Figure 253d

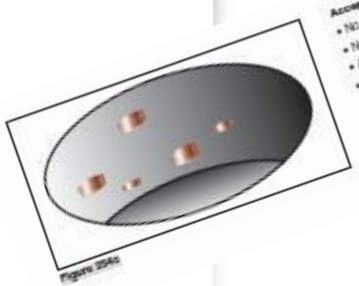

Figure 254c

Acceptable – Class 1

- No more than two voids in any hole.
- Not more than 15% of the holes have voids.
- Any void is not more than 10% of the hole length.
- All voids are less than 90° of the circumference.

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3.3.18 Copper Wrap Plating (cont.)

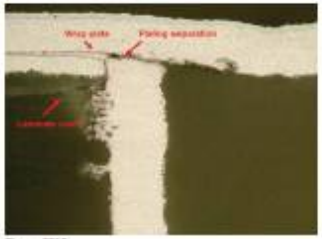

Figure 3318e

Nonconforming – Class 3, 2, 1
- Defects either do not meet or exceed above criteria.

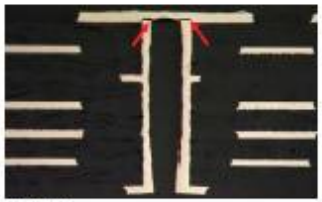

Figure 3318f

Plated Copper Filled Microvias

Figure 3320b

Target Condition – Class 3, 2, 1
- Copper filled microvias completely filled with copper with no voids.

Figure 3320d

Nonconforming – Class 3, 2, 1
- Defects either do not meet or exceed above criteria.

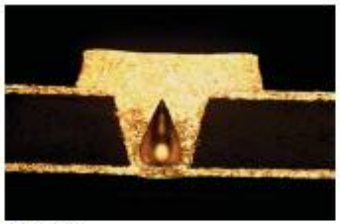

Figure 3320e

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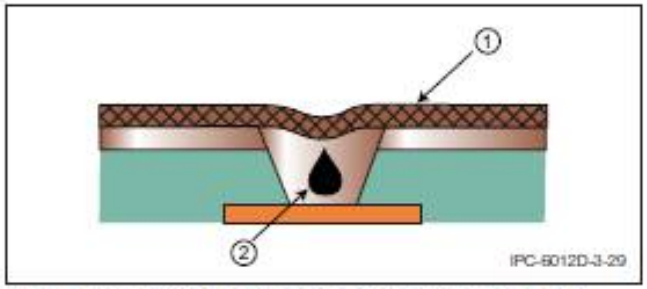

Figure 3-29 Example of Acceptable Voiding in a Cap Plated, Copper Filled Microvia
Note 1: Copper cap plating, if specified.
Note 2: Void/Cavity.

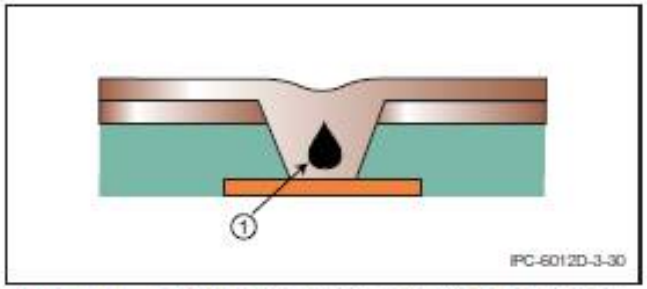

Figure 3-30 Example of Acceptable Voiding in a Copper Filled Microvia without Cap Plating
Note 1: Void/Cavity.

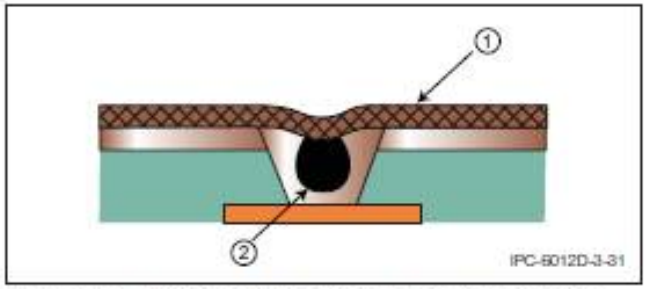

Figure 3-31 Example of Nonconforming Void in a Cap Plated, Copper Filled Microvia
Note 1: Copper cap plating, if specified.
Note 2: Void/Cavity.

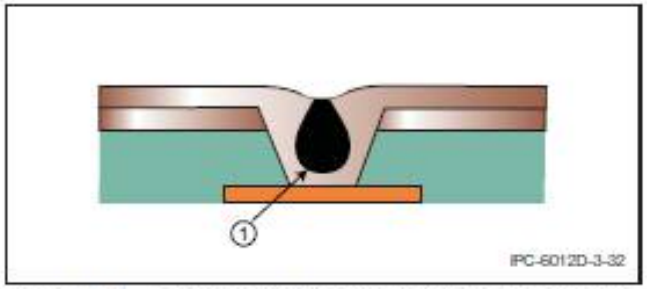

Figure 3-32 Example of Nonconforming Void in a Copper Filled Microvia
Note 1: Void/Cavity.

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- 3.7 Solder Mask Requirements Minor changes,
  - Solder mask coverage on round and square smt pads
  - Cure and adhesion

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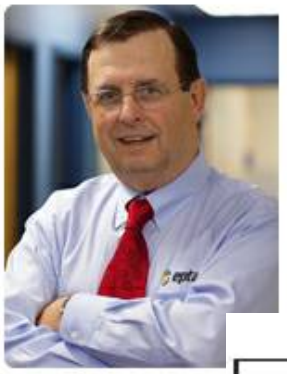
6012 Critical Tables

Table 4-1 Qualification Test Coupons

Test	Type 1	Types 2,3,5	Types 4, 6	Printed Board[3]
Visual[1]	All	All	All	X
Solderability Surface[1] Hole[1]	 M2, M5 –	 – S1,S6	 – S1,S6	 – –
Dimensional[1]	All	All	All	X
Physical Plating Adhesion[1] Bond Strength	 N1, N4, N5 A2, A3, A6	 N1, N4, N5 –	 N1, N4, N5 –	 – –
Construction Integrity PTH Prior to Stress Additional Dimensions	 – –	 A1, A4, A5 A1, A4, A5	 Design Requirement Design Requirement	 – –
PTH After Stress Thermal Stress Horizontal micro (Metal Core) Rework Simulation	 – – –	 A1, A4, A5 B4, B5 B3, B6	 Design Requirement A1, B4, B5 Design Requirement	 – – –



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Acceptance Testing and Frequency

Table 4-3 Acceptance Testing and Frequency

Inspection	Requirement and Method Section	Sample		Test Frequency			Remarks
		Printed Board	Test Coupon By Printed Board	Class 1[1]	Class 2[1]	Class 3[1]	
Material	3.2.1-3.2.14			Manufacturer's Certification			Verifiable certificate of compliance or SPC program
Visual							
Edges of Printed Board	3.3.1	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	Per Printed Board
Laminate Imperfections	3.3.2	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	Per Printed Board
Plating and Coating Voids In the Hole	3.3.3	X		Sample (4.0)	Sample (2.5)	Sample (1.0)	Per Printed Board
Lifted lands	3.3.4	X		Sample (6.5)	Sample (4.0)	Sample (4.0)	Per Printed Board
Marking and traceability	3.3.5	X	Coupons and Printed Board	Sample (6.5)	Sample (4.0)	Sample (4.0)	Per Printed Board

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Appendix A

APPENDIX A

Appendix A presents the performance requirements of IPC-6012D in an abbreviated form and alphabetical order. Special conditions, lengthy requirements, and tutorial information may be shortened or partially omitted in this appendix. See the referenced paragraph in this appendix for the full specification requirements.

Characteristic Inspection	Requirements			Requirement Paragraph
	Class 1	Class 2	Class 3	
Etched Annular Ring (External PTHs)	Not greater than 180° breakout of hole from land when visually assessed.	Not greater than 90° breakout of hole from land when visually assessed.	The minimum annular ring **shall** be 50 µm [1,969 µin].	3.4.2 and Table 3-9
Etched Annular Ring (External Unsupported Holes)	Not greater than 90° breakout of hole from land when visually assessed.		The minimum annular ring **shall** be 150 µm [5,906 µin].	3.4.2 and Table 3-9
Etched Annular Ring (Internal PTHs)	Hole breakout is allowed provided the land/conductor junction is not reduced below the allowable width reduction in 3.5.3.1.	90° hole breakout is allowed provided the land/conductor junction is not reduced below the allowable width reduction in 3.5.3.1.	The minimum internal annular ring **shall** be 25 µm [984 µin].	3.6.2.9 and Table 3-9
	For Class 1 and Class 2 product, breakout is allowed if modified land shapes such as filleting or "keyholing" have been employed. For Class 1 and Class 2 product, if filleting or keyholing have not been employed on lands, the minimum annular ring **shall** be 25 µm [984 µin].			
Etched Annular Ring (Microvia Capture Land)	Not greater than 180° breakout of hole from land when visually assessed. The land/conductor junction **shall not** be reduced below the allowable width reduction in 3.5.3.1.	Not greater than 90° breakout of hole from land when visually assessed. The land/conductor junction **shall not** be reduced below the allowable width reduction in 3.5.3.1. The conductor junction should never be less than 50 µm [1,969 µin] or the minimum line width, whichever is smaller.	There **shall** be no evidence of breakout.	3.4.2 and Table 3-9

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- Provided more information on haloing, definition and pictures
- Minor changes were made in Crazing, Delamination and Foreign Inclusions

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Section 2.10.3

- Illustration started using teardrop pads to help with issues in the land to conductor junction area.

2.10.3 External Annular Ring – Supported Holes and Microvia Capture Land (cont.)

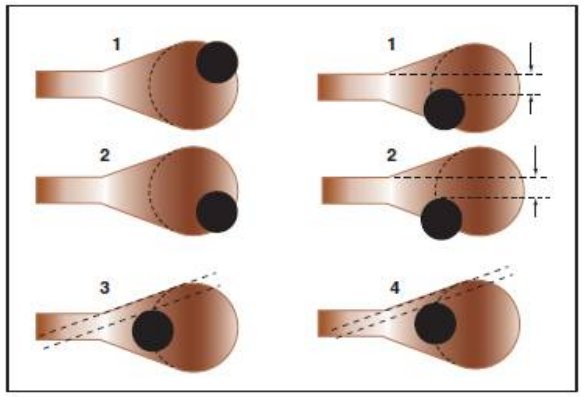

Figure 2103d
Note 1: 90° Breakout or less
Note 2: 180° Breakout or less
Note 3: Conductor junction reduction not more than 20%
Note 4: Conductor junction reduction not more than 30%

Acceptable – Class 2

- 90° breakout or less (see item 1 in Figure 2103d).
- Breakout at the conductor to land junction area does not reduce the junction more than 20% of the minimum conductor width specified on the engineering drawing or the production master nominal. The conductor junction is not less than 0.050 mm [0.0020 in] or the minimum line width, whichever is smaller (see item 3 in Figure 2103d).
- Minimum lateral spacing is maintained.

Acceptable – Class 1

- 180° breakout or less (see item 2 in Figure 2103d).
- Breakout at the conductor to land junction area does not reduce the junction more than 30% of the minimum conductor width specified on the engineering drawing or the production master nominal (see item 4 in Figure 2103d).
- Form, fit and function are not affected.
- Minimum lateral spacing is maintained.

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Section 3.1.1

3.1.1 Laminate Voids/Cracks (Outside Thermal Zone)

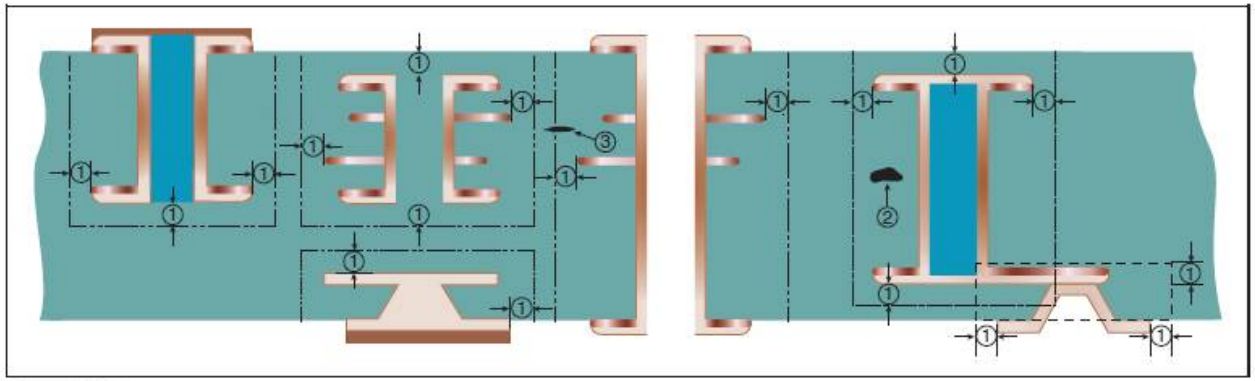

Figure 311a

Note 1: Thermal zones are defined by a 0.08 mm [0.0031 in] perimeter around the entirety of each via or through-hole structure (including internal and external lands). For lands that are increased in size to accommodate an offset (staggered) structure, the thermal zone is governed by the offset (staggered) structure.
Note 2: Laminate voids and cracks fully encapsulated within thermal zones are not evaluated on specimens which have been exposed to thermal stress or rework simulation.
Note 3: Delamination/Blistering is evaluated regardless of whether any portion of the anomaly is within or without a thermal zone.
Note 4: Laminate voids and cracks resulting from sample removal that are limited to the edges of the sample (at either end of the microsection specimen) are not evaluated on specimens which have been exposed to thermal stress or rework simulation.

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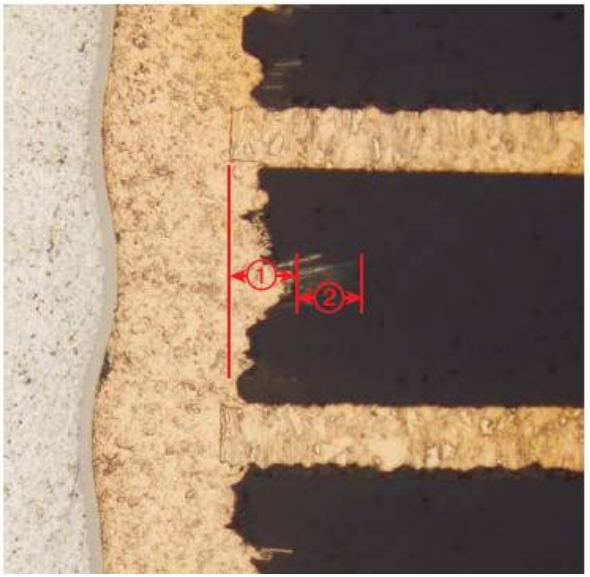
Section 3.1.5.1

Updated the criteria for etchback and wicking in combination



Acceptable – Class 3, 2, 1

- Etchback between 5 µm [197 µin] and 80 µm [3,150 µin].
- The combination of dielectric removal from etchback plus wicking allowance (wicking and random tears or drill gouges resulting from hole formation and/or hole cleaning) does not exceed the sum of the maximum allowable etchback removal and the maximum allowable wicking limits of 3.3.4. In no case can the individual maximum conditions of wicking or etchback be exceeded.
- Shadowing is permitted on one side only of each land.

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3.3.3 Plating Folds/ Inclusions

3.3.3 Plating Folds/Inclusions

Measurement points for plating folds/inclusions are shown in Figure 333a.

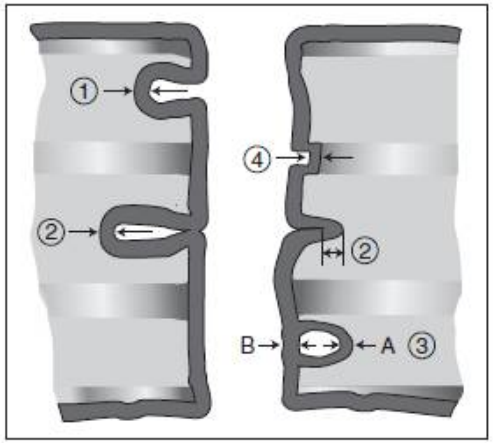

Figure 333a

Note 1: Minimum copper plate measurement point. Plating folds that are not enclosed and where the minimum copper plate thickness in IPC-6010 performance series specifications is met are acceptable.

Note 2: Enclosed plating folds (inclusions) with demarcation line visible. Measure and accept per Note 1.

Note 3: Enclosed plating fold with no visible demarcation line. The thickness measurement A+B **shall** comply with the minimum copper plate thickness in the IPC-6010 performance series.

Note 4: Minimum copper plate measurement point for negative etchback.

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3.3.12 Annular Ring – Internal Layers

3.3.12 Annular Ring – Internal Layers (cont.)

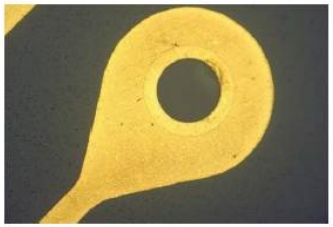

Figure 3312b

Target Condition – Class 3, 2, 1

- All holes accurately registed in the center of the lands.

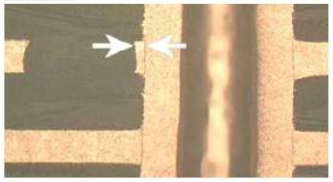

Figure 3312c

Acceptable – Class 3

- Annular ring measures 25 µm [984 µin] or more.

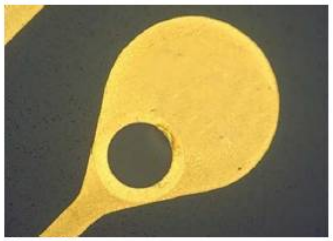

Figure 3312d

Acceptable – Class 2

- 90° hole breakout is allowed provided the land/conductor junction is not reduced below the allowable width reduction in 2.10.1.1, modified land shapes such as filleting or keyholing have been employed and minimum lateral spacing is maintained.
- Annular ring measures 25 µm [984 µin] or more if modified land shapes such as filleting or keyholing have not been employed on lands.

Acceptable – Class 1

- Hole breakout is allowed provided the land/conductor junction is not reduced below the allowable width reduction in 2.10.1.1, modified land shapes such as filleting or keyholing have been employed and minimum lateral spacing is maintained.
- Annular ring measures 25 µm [984 µin] or more if modified land shapes such as filleting or keyholing have not been employed on lands.

3.3.12 Annular Ring – Internal Layers (cont.)

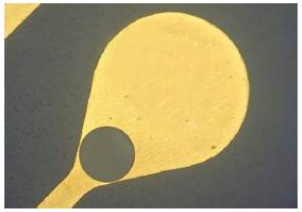

Figure 3312e

Nonconforming – Class 3, 2, 1

- Defects either do not meet or exceed above criteria.

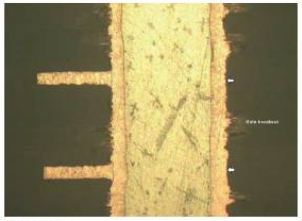

Figure 3312f

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3.3.20 Plated Copper Filled Microvias (Blind and Buried)

3.3.20 Plated Copper Filled Microvias (Blind and Buried)

Requirements for protrusions (bumps) or depressions (dimples) in blind copper filled microvias **shall** be AABUS. There are no protrusion or depression requirements for buried copper filled microvias.

Copper filled microvias are exempt from copper wrap requirements when overplated with 5 µm [0.0002 in] minimum copper thickness as shown in Figure 3320a below. Separation of the overplate to underlying plating and copper fill **shall not** be acceptable.

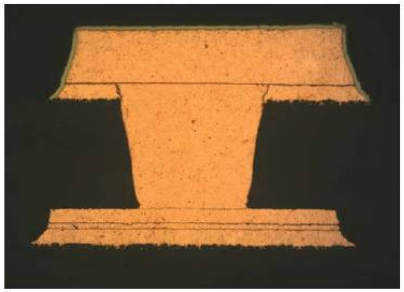

Figure 3320a
Note: Example of exemption from copper wrap requirements with 5 µm [0.0002 in] copper over plate.

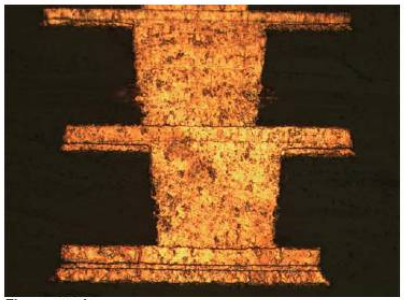

Figure 3320b

Target Condition – Class 3, 2, 1

- Copper filled microvias completely filled with copper with no voids.

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Section 4 Flexible and Rigid-Flex Boards

- Some of the sections were rewritten:
- 4.1.5, Stiffener Bonding
- 4.1.8.1, Flex Boards
- 4.1.8.2 , Rigid-flex Boards
- 5.1, Solderability Testing

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Which One to Choose

- If you are getting boards fabricated and creating the design, IPC-6012 is the spec.
- If you are inspecting boards as they come into your facility for assembly, then IPC-A-600 is the spec.

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Questions?

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Thank You

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Further Information

For questions regarding this webinar, please contact Leo Lambert at leo@eptac.com

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