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IPC/JPCA-6202

Performance Guide Manual for Single- and Double-Sided Flexible Printed Wiring Boards

IPC/JPCA-6202

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A joint standard developed by IPC and JPCA

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Developed by the Flexible Circuits Acceptability Subcommittee (D-14) of the Flexible Circuits Committee (D-10) of IPC and the Flexible Printed Circuits Committee of the Japan Printed Circuit Association (JPCA)

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

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Acknowledgment

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Performance Guide Manual for Single- and Double-Sided Flexible Printed Wiring Boards

1 SCOPE

This standard covers the requirements and considerations for single- and double-sided flexible printed wiring boards (hereinafter called “flexible printed boards” or FPC).

In this document, a FPC means a single- or double-sided FPC, using a film of polyester or polyimide laminated with copper foil(s) on one or both sides (including types with no adhesive layer), and manufactured by the subtractive method (excluding the build-up methods for the manufacturing process).

2 REFERENCED DOCUMENTS

The referenced documents for this standard are as stated in 2.1 through 2.3.

2.1 Japan Printed Circuits Association¹

JIS C 5016 (1994) Test Methods for Flexible Printed Wiring Boards

JIS C 5017 (1994) Flexible Printed Wiring Boards - Single-Sided and Double-Sided

JIS C 5603 (1993) Terms and Definitions for Printed Circuits

JIS C 6471 (1995) Test Methods of Copper-Clad Laminates for Flexible Printed Wiring Boards

JIS C 6472 (1995) Copper-Clad Laminates for Flexible Printed Wiring Boards (Polyester Film, Polyimide Film)

JIS C 6512 (1992) Electrolytic Copper Foil for Printed Wiring Boards

JIS C 6513 (1996) Rolled Copper Foil for Printed Wiring Boards

JPCA-FC03 (1992) Specification for External Appearance of Flexible Printed Wiring Boards

2.2 International Electrotechnical Commission²

IEC 326-7 (1981) Printed Boards. Part 7: Specification for single and double sided flexible

printed boards without through connections.

IEC 326-8 (1981) Printed Boards. Part 8: Specification for single and double sided flexible printed boards with through connections.

These IEC documents are, however, being reviewed for substantial revision at the time of enactment of this document.

2.3 IPC³

ANSI/IPC-FC-250 Specification for Single- and Double-Sided Flexible Printed Wiring

IPC-A-600 Acceptability of Printed Boards

IPC-TM-650 Test Methods Manual

2.4.13 Solder Float Resistance Flexible Printed Wiring Materials

3 DEFINITION OF TERMS

The definition of terms used in this document is in conformance with JIS C 5603, JIS C 5017, JIS C 5016, and JPCA-FC03.

4 TEST METHODS

The test methods for the properties specified in this document are, in principle, in conformance with JIS C 5016, provided:

- (1) Test methods requiring complicated referencing procedures are reproduced in this document.
- (2) Tests on through connection apply to double-sided FPCs only.
- (3) For stiffeners affixed to FPCs, external appearance is the only requirement specified in this document.

5 PERFORMANCE LEVELS

The FPCs are classified into three standard levels and one special level regarding their performance for each requirement. These are defined as follows:

- Level 1 – FPCs requiring “ordinary” performance levels
- Level 2 – FPCs requiring “high” performance levels

1. JPCA, Kairo Kaikan 2F, 12-2, Nishiogikita 3-Chome, Suginami-Ku, Tokyo, 167, Japan, +81-3-5310-2020, www.jpca.org

2. ANSI, 11 W. 42nd St., New York, NY 10036, 212-642-4980, www.ansi.org

3. IPC, 2215 Sanders Rd., Northbrook, IL 60062-6135, 847-509-9700, www.ipc.org



- Level 3 – FPCs requiring “extra-high” performance levels
- Level X – FPCs requiring special performances, which do not belong to the three quality levels mentioned above, and the specifications for which must be clearly defined between manufacturer and customer.

These levels hold valid throughout this document and can be used by selecting an appropriate level for each requirement. On the other hand, in a FPC that partially contains special requirement(s) such as fine circuits, applications of flexing use, and COFs, including wire bonding and flip-chip packaging, Level X can only apply to the area of these special requirements. The requirements that are not specified for each level apply to Level 1, Level 2, and Level 3.

6 BASE MATERIALS

The base materials used for FPCs **shall** be the materials of polyester film or polyimide film specified in JIS C 6472, which are laminated, by the use of an adhesive or other bonding methods, with a copper foil for printed boards specified in JIS C 6512 and JIS C 6513, or with a copper foil having a performance equivalent to that; and their properties **shall** be in accordance with the requirements of JIS C 6472.

7 VISUAL INSPECTION

7.1 Test Environment The testing environment **shall** be in accordance with the requirements of JIS C 5016, paragraph 3, “Test Conditions.”

7.2 Test Specimens The specimens used **shall** be in accordance with the requirements of JIS C 5016, paragraph 4, “Test Specimens.”

7.3 Tools for Testing A magnifying glass having a magnification of 3X to 10X **shall** be used for examining the appearance and surface finish conditions of the product. Dimensions **shall** be measured with a graduated loupe or a two-dimensional coordinate measuring instrument, if necessary. Thickness **shall** be measured with a micrometer having an accuracy of 1 μ m or higher.

7.4 Preparation of Limit Samples For smooth application of this document, the limit samples showing the required criteria to make technical judgements may be prepared under agreement between manufacturer and customer.

7.5 Description of Inspections Requirements, procedures, and illustrations for visual inspections are given in 7.5.1 through 7.5.7.4. Requirements that are not designated for a specific performance level **shall** apply to performance Level 1, Level 2, and Level 3.

7.5.1 Visual Inspection of Conductors Conductors having widths ≤ 0.15 mm, as well as other conductors with particular requirements, such as bonding area of FPCs for wire bonding use, may be excluded from application of the specifications described in this document, when agreed upon by manufacturer and customer.

7.5.1.1 Open and Short Circuits There **shall** be no open and/or short circuits on FPCs.

7.5.1.2 Nicks and Pinholes on Conductors

- (1) The allowable width ($w1$) and length (l) of nick(s) and pinhole(s) on conductors reducing conductor width, as shown in Figure 1, **shall** meet the requirements of Table 1 for the finished conductor width (W) (see Note 1).

Table 1 Allowable Nicks and Pinholes

Level	Nicks and Pinholes
1 and 2	$w1 \leq \frac{1}{2}W$ $l \leq 2W$
3	$w1 \leq \frac{1}{3}W$ $l \leq W$

Note 1: The width of finished conductors **shall** be measured at the bottom of the conductor.

- (2) The void area on a land, as shown in Figure 2, **shall** not exceed 10% of the effective exposed land area.
- (3) The circumferential void at the hole corner of a component hole, as shown in Figure 3, **shall** not exceed $\frac{1}{3}$ of the total circumference.

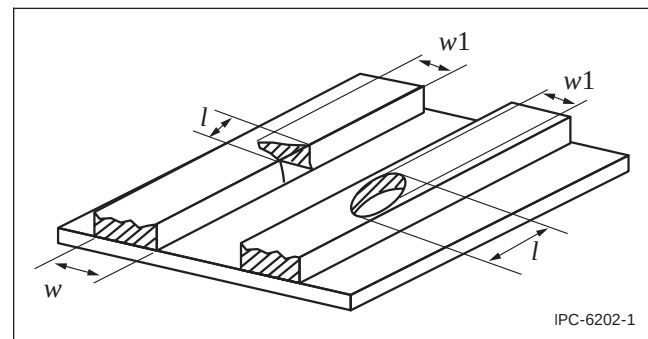


Figure 1 Nicks and Pinholes in Conductor

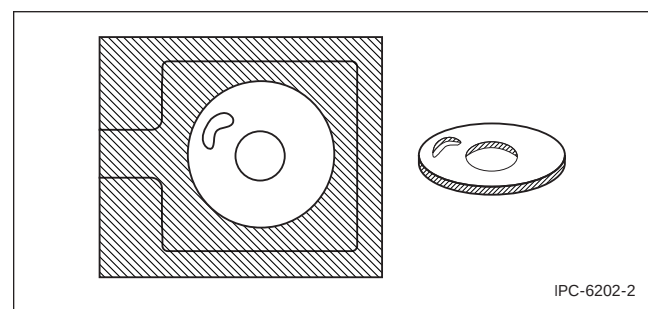


Figure 2 Reduced Area on Land

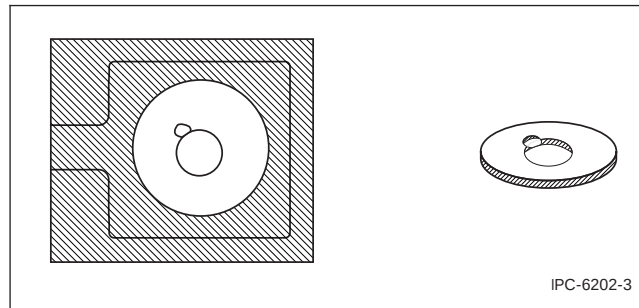


Figure 3 Circumferential Void at the Component Hole Corner

7.5.1.3 Extraneous Copper Between Conductors / Spurs and Nodules of Conductor The spacing (a) or (a1 + a2) in Figure 4 **shall** meet the requirements of Table 2 relative to the finished conductor spacing (b); where (a) is the peak to peak spacing between spurs and nodules of conductors, and (a1) and (a2) is the spacing between an extraneous copper and its neighboring conductors.

7.5.1.4 Extraneous Copper Between Conductors/Spurs and Nodules of Conductor in Open Area In an open area where no conductor pattern is routed, as shown in Figure 5, the spacing (c) between the board edges and the extraneous copper or spurs and nodules **shall** not be <0.125 mm. The spacing (d) between the neighboring conductor and the extraneous copper or the spurs and nodules **shall** not be <0.125 mm.

7.5.1.5 Etched Concave on Conductor Surface Etched concave areas (e) on the conductor surface relative to the conductor thickness (t), shown in Figure 6, **shall** meet the requirements of Table 3. The concave area **shall** not run across the width of a conductor.

7.5.1.6 Conductor Delamination The width (w1) and length (l) of a conductor delamination relative to the finished conductor width (W), as shown in Figure 7, **shall** meet the requirements of Table 4.

7.5.1.7 Conductor Cracks There **shall** be no cracks in the conductor.

Table 2 Allowable Extraneous Copper and Spurs and Nodules Between Conductors

Level	Extraneous Copper/Spurs and Nodules
1 and 2	a or (a1 + a2) $\geq \frac{1}{2} b$
3	a or (a1 + a2) $\geq \frac{2}{3} b$

7.5.1.8 Scratches on Conductor A scratch on a conductor surface, as shown in Figure 8, indicates the ones made by a sharp metal end and are harmful to the performance of the printed circuit. The depth (f) of a scratch **shall** meet the requirements of Table 5 relative to the conductor thickness (t). Further, the scratch **shall** not adversely affect the bending property of the repeatedly flexing portion.

7.5.1.9 Dents Dents on a conductor, as shown in Figure 9, **shall** meet the requirements of Table 6. Dent conditions are usually difficult to judge (i.e., shape, size, and depth); accordingly, details should be agreed upon between manufacturer and customer with limit samples prepared for these evaluations.

7.5.1.10 Discoloration Discoloration **shall** meet the requirements of Table 7.

7.5.2 Visual Inspection of Base Film

7.5.2.1 Dents Dents on the base film, as shown in Figure 9, **shall** meet the requirements of Table 8.

7.5.2.2 Scratches on Base Film The depth (i) of a scratch on a base film relative to the film thickness (t), as shown in Figure 10, **shall** meet the requirements of Table 9.

There **shall** be no sharp pressed mark, cut, tear, and delaminated adhesive layer. Further, these defects **shall** not adversely affect the bending property of the repeatedly flexing part.

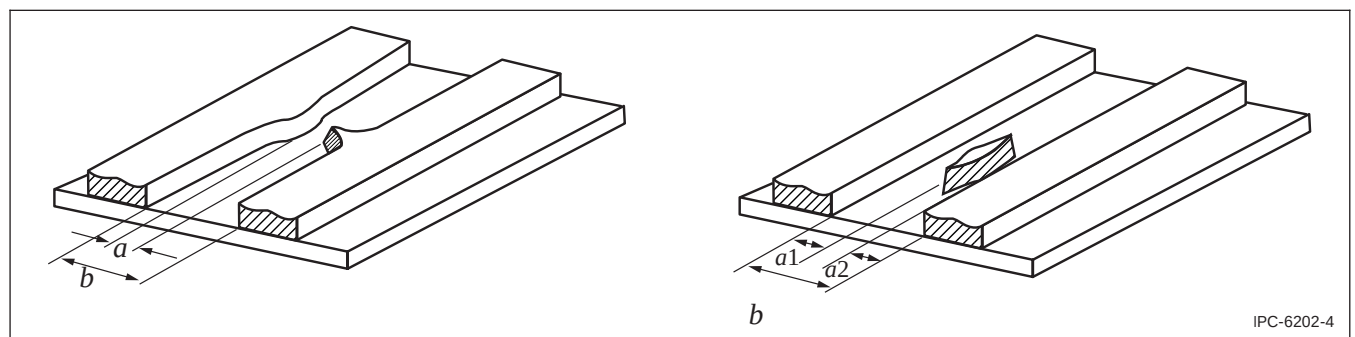


Figure 4 Extraneous Copper Between Conductors/Spurs and Nodules of Conductors Corner

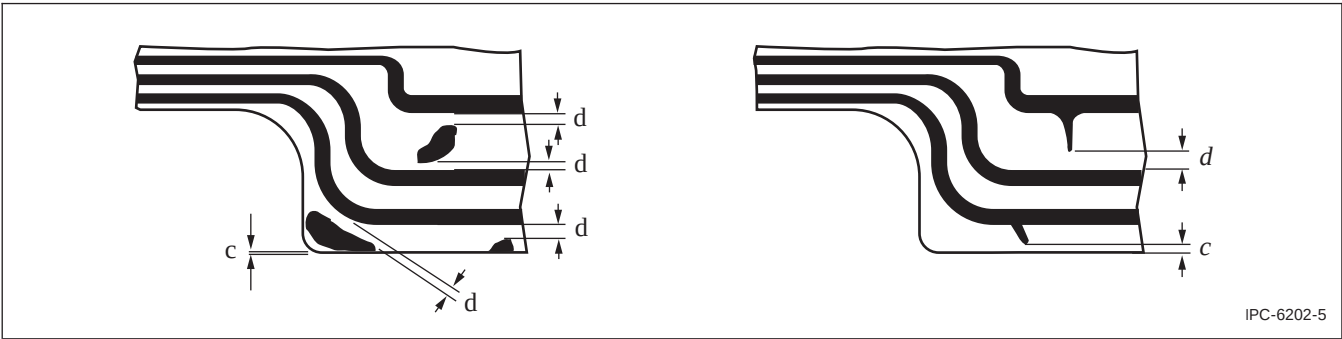


Figure 5 Extraneous Copper and Spurs and Nodules in Open Area and Nodules of Conductors Corner

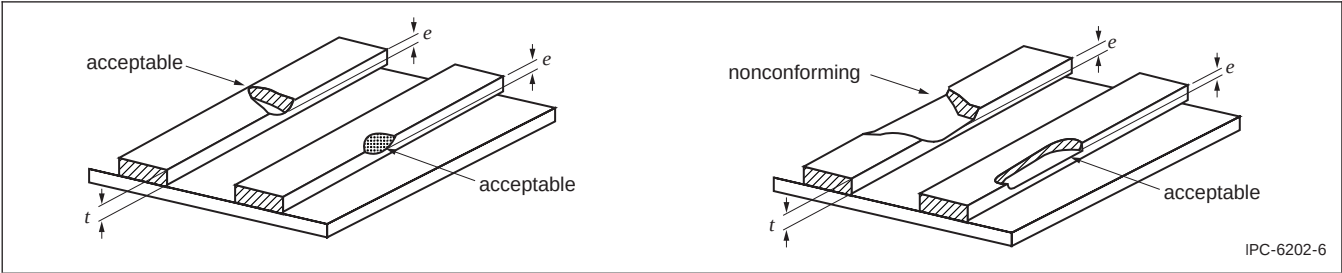


Figure 6 Etched Concave on Conductor Surface and Nodules of Conductors Corner

Table 3 Allowable Etched Concave on Conductor Surface

Level	Etched Concave on Conductor Surface
1 and 2	$e \leq \frac{1}{3} t$
3	$e \leq \frac{1}{5} t$

Table 4 Allowable Conductor Delamination

Level	Conductor Delamination
1	(1) Coverlay laminated area $l < W$ and $w1/W < \frac{1}{3}$ for flexing area $l < W$ and $w1/W < \frac{1}{2}$ for other area
	(2) No coverlay laminated area $l/W < \frac{1}{4}$ and $w1/W < \frac{1}{4}$
2 and 3	No delaminaton allowed

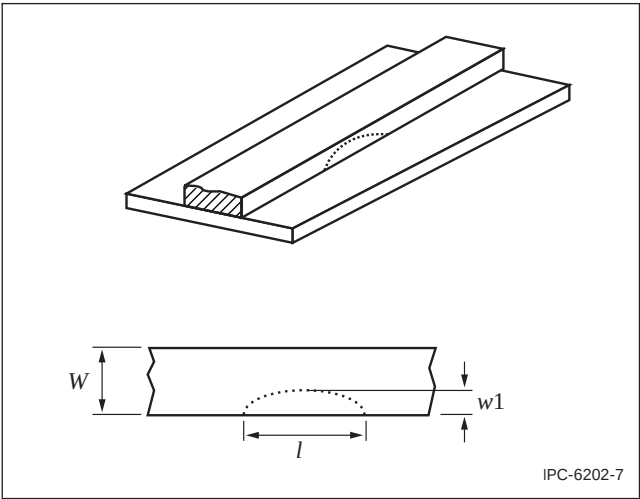


Figure 7 Conductor Delamination

7.5.3 Visual Inspection of Coverlay and Covercoat

7.5.3.1 Dents on Coverlay and Covercoat Dents on coverlay and covercoat, as shown in Figure 9, **shall** meet the requirements of Table 10.

7.5.3.2 Scratches on Coverlay and Covercoat The depth (i) of a scratch on the coverlay and covercoat relative to the thickness (t) of coverlay or covercoat, shown in Figure 10, **shall** meet the requirements of Table 11.

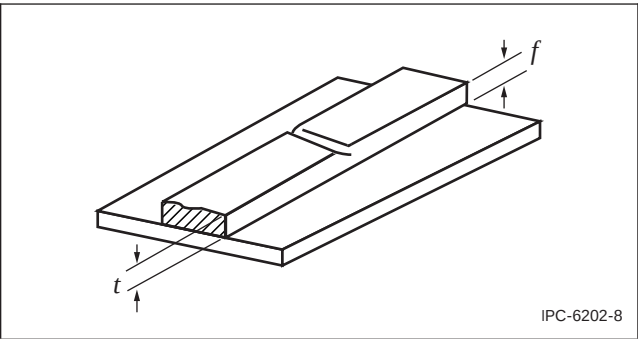


Figure 8 Scratches on Conductor

Table 5 Allowable Scratches on Conductor

Level	Scratches on Conductor
1 and 2	$f \leq \frac{1}{3} t$
3	$f \leq \frac{1}{5} t$

There **shall** be no sharp pressed mark, cut, tear, and delaminated adhesive layer on the surface of the coverlay or covercoat. Further, these defects **shall** not adversely affect the bending property of the repeatedly flexing portion.

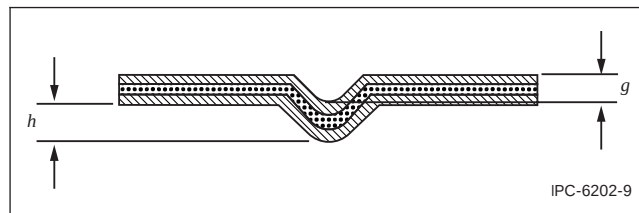


Figure 9 Dents

Table 6 Allowable Dents

Level	Dents
1 and 2	Depth (g) of dents from the surface shall be ≤ 0.1 . When depth is difficult to measure, the height (h) of the backside protrusion of the base film shall be regarded as equal to the depth (g) of dent.
3	There shall be no dents visible from both sides.

Table 7 Discoloration

Level	Discoloration
1 and 2	When discoloration is observed on a conductor laminated with coverlay, the specimen, after conditioning at 40°C with 90% RH for 96 hours, shall meet the requirement for flexural strength, and after pre-drying, shall meet the requirement for solder temperature resistance.
3	The degree of acceptable discoloration shall be as agreed upon using the limit sample. If the degree of acceptable discoloration is exceeded, test the specimen per IPC-TM-650, Method 2.4.13.

Table 8 Dents

Level	Dents
1 and 2	Depth (g) of dents from the surface shall be ≤ 0.1 mm. When depth is difficult to measure, the height (h) of the backside protrusion of the base film shall be regarded as equal to the depth (g) of dent.
3	There shall be no dents visible from both sides.

Table 9 Allowable Scratches on Base Film

Level	Scratches on Base Film
1 and 2	$i \leq \frac{1}{3} t$
3	$i \leq \frac{1}{5} t$

Table 10 Dents on Coverlay and Covercoat

Level	Dents
1 and 2	Depth (g) of dents from the surface shall be ≤ 0.1 mm. When depth is difficult to measure, the height (h) of the backside protrusion of the base film shall be regarded as equal to the depth (g) of dent.
3	There shall be no dents visible from both sides.

Table 11 Requirements for Scratches on Coverlay and Covercoat

Level	Scratches
1	There shall be no exposure of conductor.
2	Depth (i) $\leq \frac{1}{3}$ of thickness of coverlay or covercoat (t)
3	Depth (i) $\leq \frac{1}{5}$ of thickness of coverlay or covercoat (t)

Note: Thickness of the covercoat **shall** be calculated by subtracting the thickness of the FPC without covercoat from the total FPC thickness.

7.5.3.3 Void The coverfilm **shall** be uniform and free of coverfilm separations, such as wrinkles, creases, and soda strawing (see Figure 11). Non-lamination **shall** be acceptable, provided such imperfections do not violate the criteria of IPC-A-600 and all of the criteria in Table 12.

7.5.3.4 Foreign Matters Foreign matters, as shown in Figure 12, **shall** meet the following requirements.

- (1) *Conductive foreign matters* – Requirements 7.5.1.3 and 7.5.1.4 of this specification **shall** apply to conductive foreign matters.

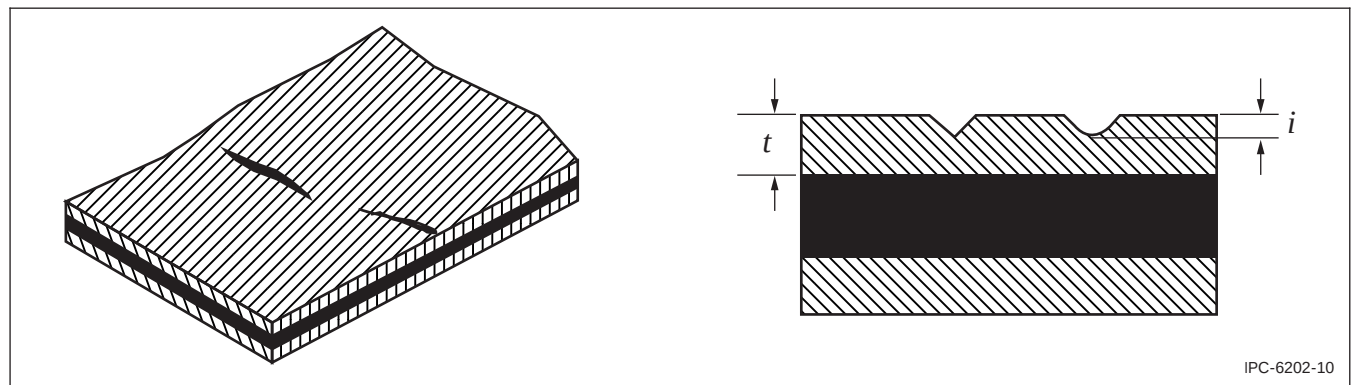


Figure 10 Scratch on Base Film

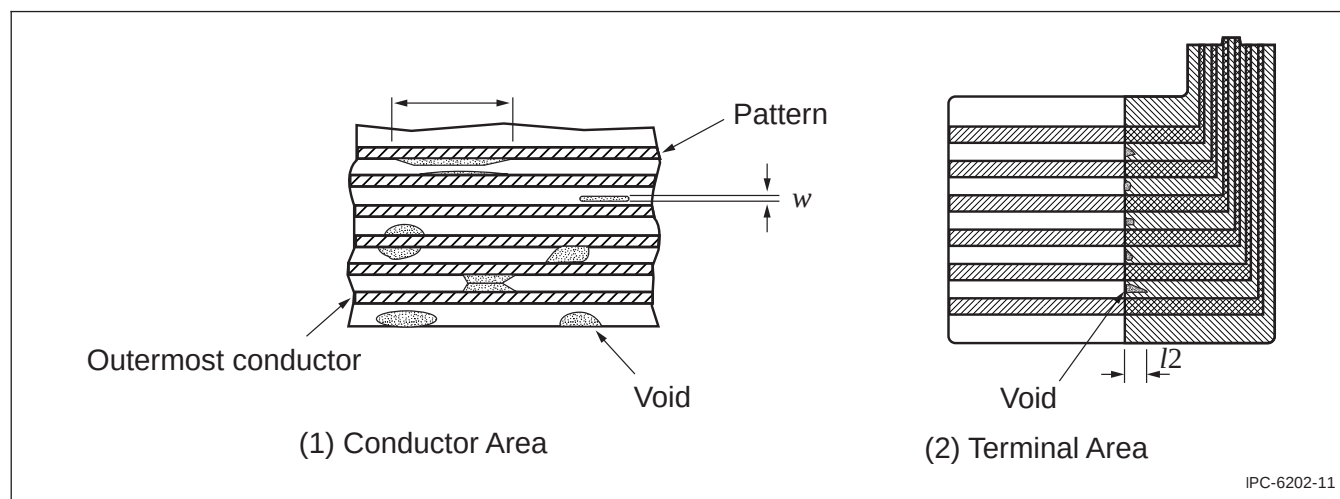


Figure 11 Allowable Voids

Table 12 Allowable Voids

Criteria	Level	Requirement
Separations away from conductors	1, 2, and 3	At random locations away from conductors, if each separation is no larger than 2.5 mm x 2.5 mm and is not within 1.0 mm of the board edge or the coverfilm opening, the total number of separations shall not exceed three in any 25 mm x 25 mm of coverfilm surface area.
Total separation	1	The length of a void shall be ≤ 10 mm.
	2	The length of a void shall be 10 mm, and the total separation shall not exceed 25% of the spacing of adjacent conductors.
	3	The length of a void shall be ≤ 0.5 mm, and the total separation shall not exceed 25% of the spacing of adjacent conductors.
Coverfilm non-lamination	1, 2, and 3	There shall be no coverfilm non-lamination along the outer edges of the coverfilm.

(2) *Non-conductive foreign matters* – Non-conductive foreign matters **shall** meet the requirements of Table 13.

7.5.3.5 Blistering and Delamination There **shall** be no visible blistering and delamination of coverlay or covercoat along the edges of the FPC, as shown in Figure 13.

The covercoat **shall** not be peeled off when using the tape test specified in JIS C 5016, paragraph 8.5.1.

7.5.3.6 Squeeze-Out of Adhesive of Coverlay and Ooze-out of Covercoat Squeeze-out (j) of coverlay adhesive or

ooze-out of covercoat, as shown in Figure 14, **shall** meet the requirements of Table 14.

On the land area, as shown in Figure 14 (1), the minimum solderable annular ring (k) after coverlay lamination and terminal hole punching **shall** meet the requirements of Table 15.

7.5-3.7 Skipping of Covercoat When tested in accordance with JIS C 501, paragraph 10.4, no solder **shall** stick onto the conductors of the covercoat-skipped area.

7.5.4 Visual Inspection of Plating

7.5.4.1 Plating Defects Plating defects **shall** meet the requirements of 7.5.4.1.1 and 7.5.4.1.2.

7.5.4.1.1 Gold Plating Gold plating **shall** meet the requirements of Table 16.

7.5.4.1.2 Tin/Lead Plating (Including Application of Cream Solder, Dip Solder, Etc.) The width of the plating defect at the terminal area, as shown in Figure 15 (1), **shall** be $\leq \frac{1}{2}$ of the finished conductor width, and the length **shall** not exceed the width of the conductor. Plating defects on the land area, as shown in Figure 15 (2) and (3), **shall** be $< 10\%$ of the total plated area (excluding the skipped plating area caused by adhesive squeeze-out). Plating defects contacting the edge of the component hole, as shown in Figure 15 (3), **shall** be $\leq \frac{1}{3}$ of the circumference. The area of plating defects **shall** be covered with adhesive.

7.5.4.2 Penetration of Plated Metal or Solder (Including Cream Solder and Dip Solder) Penetration of plated metal or solder, as shown in Figure 16, **shall** meet the following requirements:

- (1) The penetrated portion (m1, m2) between conductor and coverlay (or covercoat), as shown in Figure 16, **shall** meet the requirements of Table 1

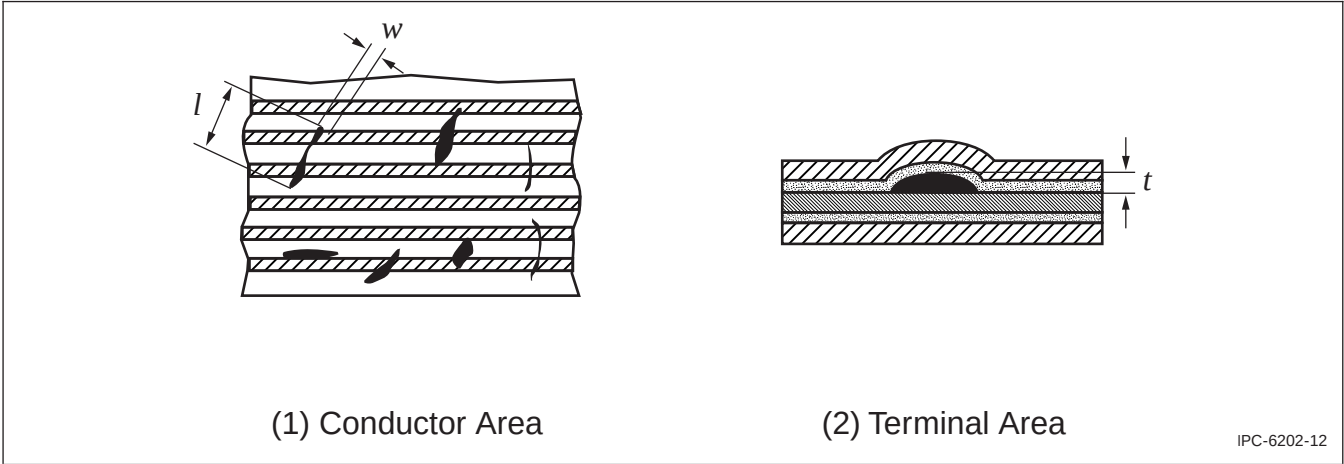


Figure 12 Foreign Matters

Table 13 Allowable Non-Conductive Foreign Materials (mm)

Level	Thickness (t)	Width (w)	Length (l)
1	≤0.1	≤0.3	≤ 3
2	≤0.05	≤0.2	≤2
3	≤0.05	≤0.05	≤1

Table 14 Allowable Squeeze-Out of Coverlay Adhesive and Ooze-out of Covercoat

Level	Squeeze-out of Cover-lay Adhesive and Ooze-out of Covercoat (mm)
1 and 2	≤0.3
3	≤0.2

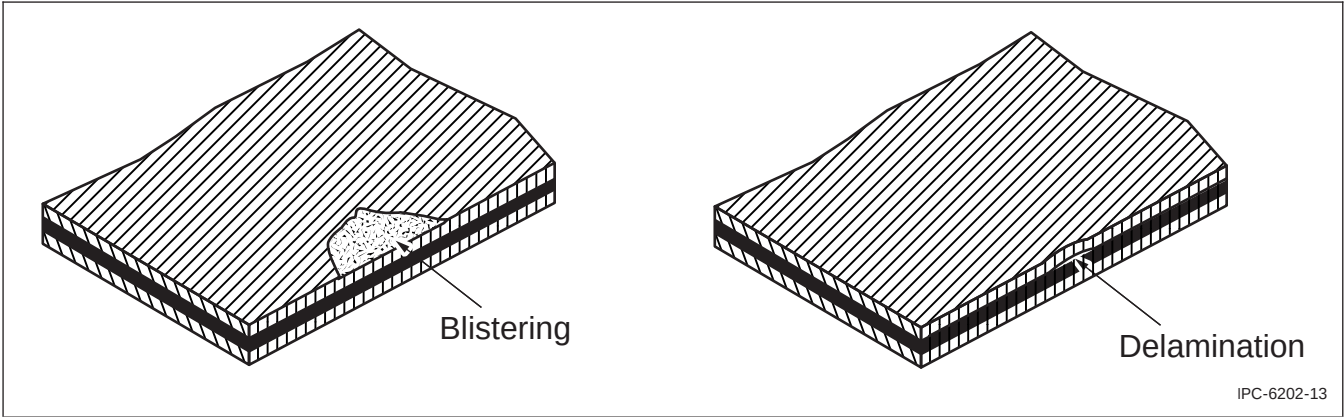


Figure 13 Lifting and Delamination of Coverlay and Covercoat

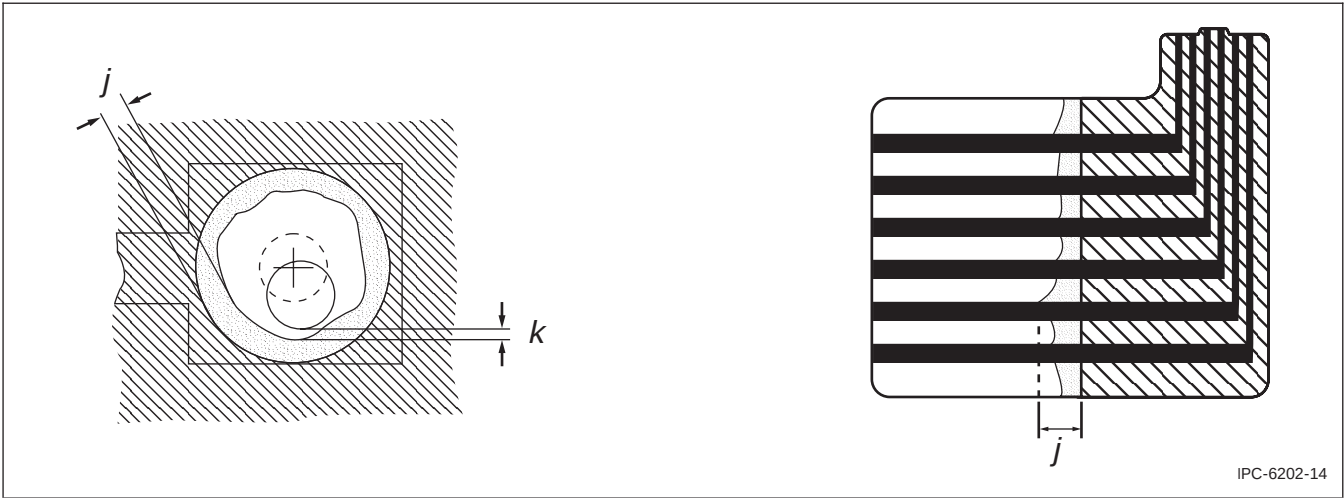


Figure 14 Allowable Squeeze-Out of Coverlay Adhesive and Ooze-Out of Covercoat

Table 15 Minimum Solderable Annular Ring on Land Area

Level	Requirement for Minimum Solderable Annular Ring
1	Squeeze-out/ooze-out contacting the hole edge is acceptable up to $\frac{1}{3}$ of terminal hole circumference.
2	Minimum 0.05 mm
3	Minimum 0.1 mm

Table 16 Gold Plating

Level	Gold Plating
1 and 2	Apply mainly to the gold plating for connectors and sliding contacts. The width of plating the defect at the terminal area shown in Figure 15 (1) shall be $\leq \frac{1}{2}$ of the finished conductor width, and the length shall not exceed the width of the conductor. There shall be no plating defects within the central $\frac{1}{3}$ portion of the terminal area (used for contacting). Plating defects on the land area, as shown in Figure 15 (2) and (3), shall be $< 10\%$ of the total plated area (excluding the skipped plating area caused by adhesive squeeze-out).
3	Apply mainly to the gold plating for COFs (wire bonding). There shall be no plating defects or pits (pinholes and/or dents) detectable at magnification of 10X at the bonding area.
X	Use this level as a specification that is agreed upon between manufacturer and customer for specifying gold plating such as for wire bonding.

(2) The penetrated portion between the conductor and base film **shall** meet the requirements of Table 18.

7.5.4.3 Surface Condition of Plated Metal and Solder

7.5.4.3.1 Gold Plating Gold plating **shall** meet the requirements of Table 19.

7.5.4.3.2 Tin/Lead Plating (Including Cream Solder and Dip Solder) There **shall** be no darkened appearance (blackening discoloration).

7.5.4.3.3 Plating Voids in Plated-Through Hole The number of plating voids shown in Figure 17 **shall** be three or fewer per hole. The total area of voids for the total hole wall area **shall** meet the requirements of Table 20.

7.5.5 Visual Inspection of Edges of Outline and Holes

7.5.5.1 Tears and Nicks There **shall** be no tears and nicks, as shown in Figure 18, except for slight cuts formed at the joining portion of blades, which are allowed, provided they are not visible without magnification.

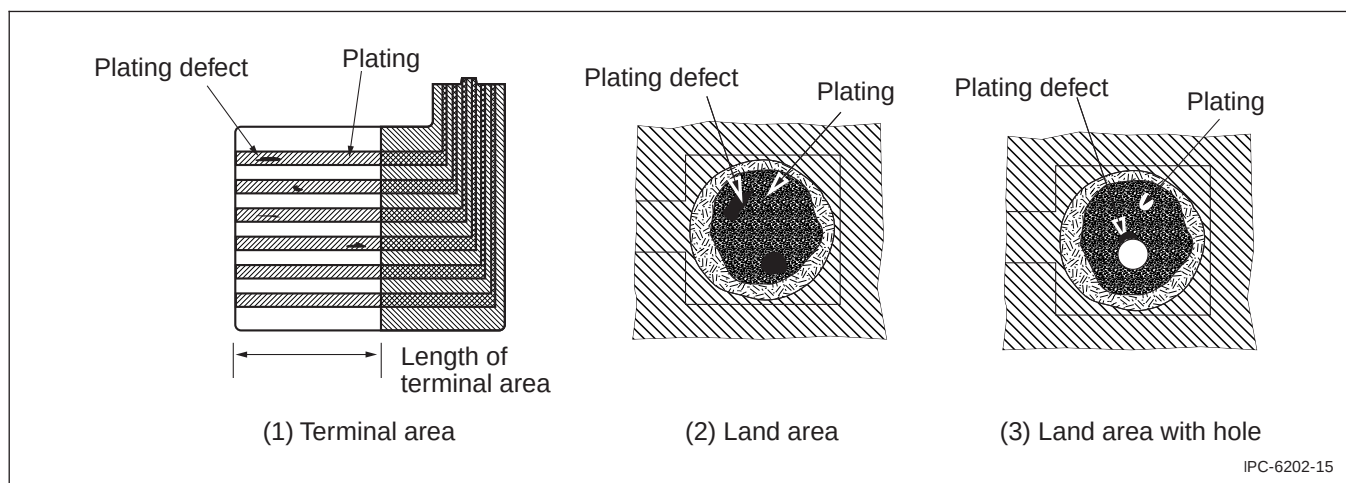
7.5.5.2 Burrs The height (n) of burrs, as shown in Figure 19, **shall** be ≤ 0.1 mm, whereas there **shall** be no burr that can cause an electrical short at the end surface of conductors.

7.5.5.3 Thready Burrs Two types of non-conductive thready burrs are shown in Figure 20. The length of thready burrs at the outline edge (L1) **shall** be ≤ 1.0 mm, and the length of those at the hole edge (L2) **shall** be ≤ 0.3 mm. Burrs **shall** not easily fall off.

7.5.6 Visual Imperfections Related to Stiffener Bonding

7.5.6.1 Foreign Matter Between Flexible Printed Board and Stiffener The bulge (p) of the FPC caused by a foreign matter sandwiched between the FPC and the stiffener, as shown in Figure 21, **shall** be ≤ 0.1 mm. When the thickness of the printed board and stiffener are specified, the thickness **shall** also meet those specifications.

The size of the foreign matter **shall** be $\leq 5\%$ of the bonding area of the printed board and stiffener.

**Figure 15 Plating Defects**

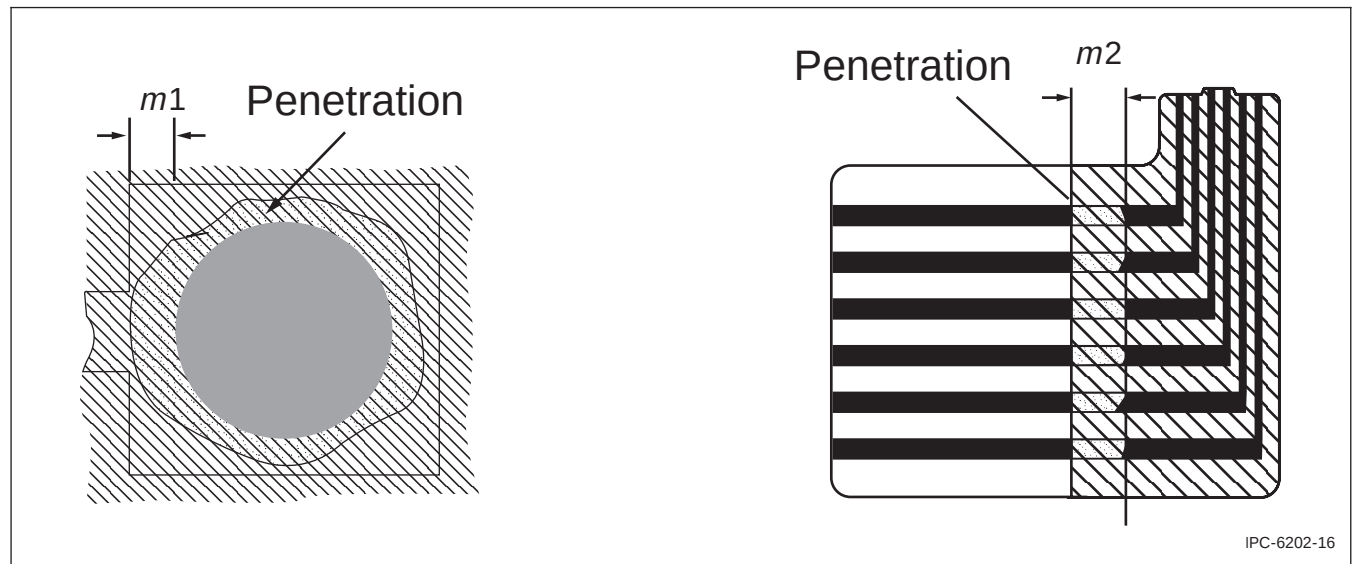


Figure 16 Penetration of Plated Metal or Solder

Table 17 Requirements for Metal Penetration Between Conductor and Coverlay

Level	Requirements for Metal Penetration (mm)
1 and 2	≤ 0.5
3	≤ 0.3

Table 18 Requirements for Metal Penetration Between Conductor and Base Film

Level	Requirement for Metal Penetration
1 and 2	Shall meet the requirement of 7.5.1.6
3	There shall be no visible penetration.

Table 19 Gold Plating

Level	Gold Plating
1 and 2	There shall be no defects such as stains, hazes, and dirt easily detectable without magnification. Slight defects are acceptable when inspected using limit samples.
3	There shall be no defects such as stains, hazes, discoloration, and dirt detectable by magnification of 10X. When necessary, details shall be specified with Level X specifically.

Further, there shall be no foreign matter in contact with the component hole or outline edges of the board.

The length of the non-conductive thready foreign matter (l) protruding from the outline edges shall not exceed 1 mm.

7.5.6.2 Voids Between Flexible Printed Board and Stiffener When the stiffener is bonded to a FPC with a thermosetting adhesive, the area of voids, as shown in Figure 22, shall be $\leq 10\%$ of the area of the stiffener. On the other hand, when other types of adhesive are used, the area of voids shall be $\leq \frac{1}{3}$ of the stiffener area. There shall be no lifting and swelling at the tip for insertion to the connector. There shall be no swelling when mounting after an appropriate baking treatment (see paragraph 3.1).

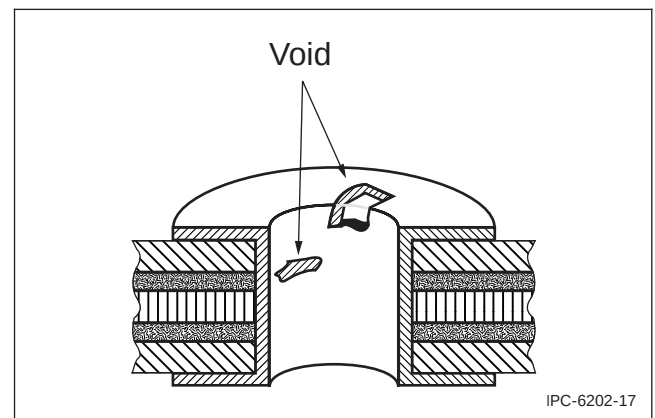


Figure 17 Plating Voids in Plated-Through Hole

Table 20 Allowable Plating Voids

Level	Total Void Area
1 and 2	$< \frac{1}{3}$
3	$< 10\%$

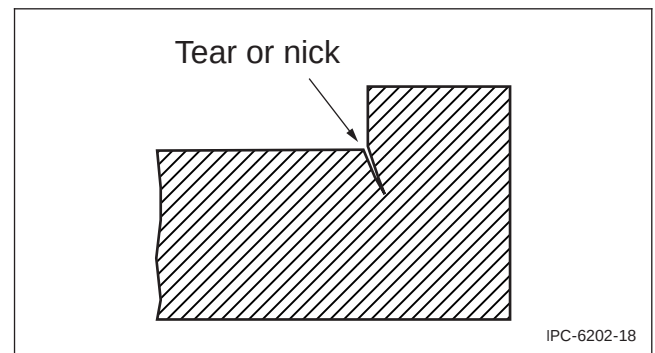


Figure 18 Tears and Nicks

7.5.6.3 Defects of Stiffener

7.5.6.3.1 Cracks Cracks, as shown in Figure 23, shall meet the requirements of Table 21.

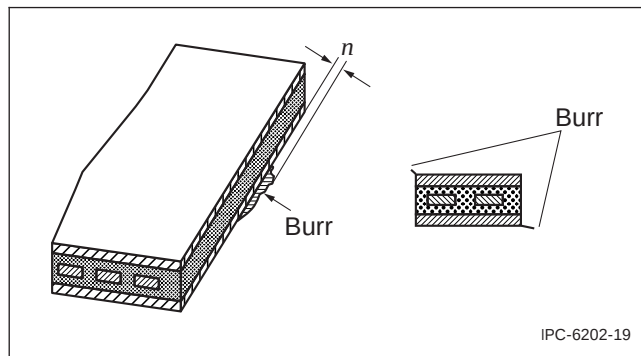


Figure 19 Burrs

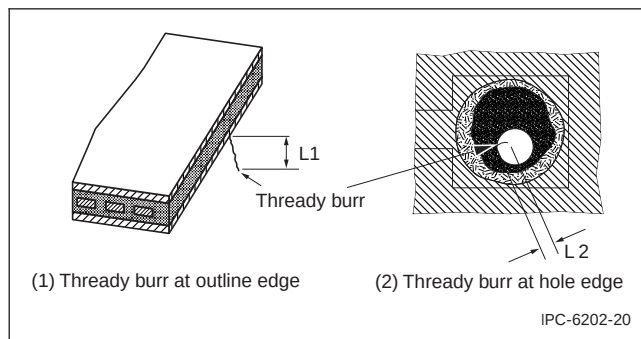


Figure 20 Thready Burrs

7.5.6.3.2 Chip-off The length (l) of a chip-off of stiffener, as shown in Figure 24, **shall** be ≤ 1 mm.

7.5.6.3.3 Scratches The allowable scratches **shall** be agreed between manufacturer and customer when necessary.

7.5.6.3.4 Deformation Deformation causing no trouble in board assembly and installment is acceptable.

7.5.7 Other Visual Inspection

7.5.7.1 Affixed Substances on the Surface

7.5.7.1.1 Thermosetting Adhesive Thermosetting adhesives on the surface **shall** meet the requirements of Table 22.

7.5.7.1.2 Flux Residues Flux residues on the surface **shall** meet the requirements of Table 23.

7.5.7.1.3 Residue of Metal Powders (Solder, Aluminum, Copper, Etc.) The following requirements **shall** apply only when metal powders falling off do not cause any trouble in the equipment mounted with the flexible printed circuit, and also the cleaning process of the customer has the capability to remove the metal powders remaining. Residue of metal powders **shall** meet the requirement of Table 24.

7.5.7.1.4 Residue of Adhesive Residue of adhesive **shall** meet the requirements of Table 25.

7.5.7.2 Protrusions and Dents There **shall** be no intensive protrusion and dent such as wrinkling and folding that would adversely affect the functionality of the assembly process and use of the FPC.

Limit samples for these defects should be prepared when necessary. Examples of protrusions and dents are shown in Figure 25.

7.5.7.3 Bow and Twist There **shall** be no intensive bow and twist, as shown in Figure 26, that would adversely affect the functionality of the assembly process and use of the FPC.

7.5.7.4 Marking Marking **shall** be legible.

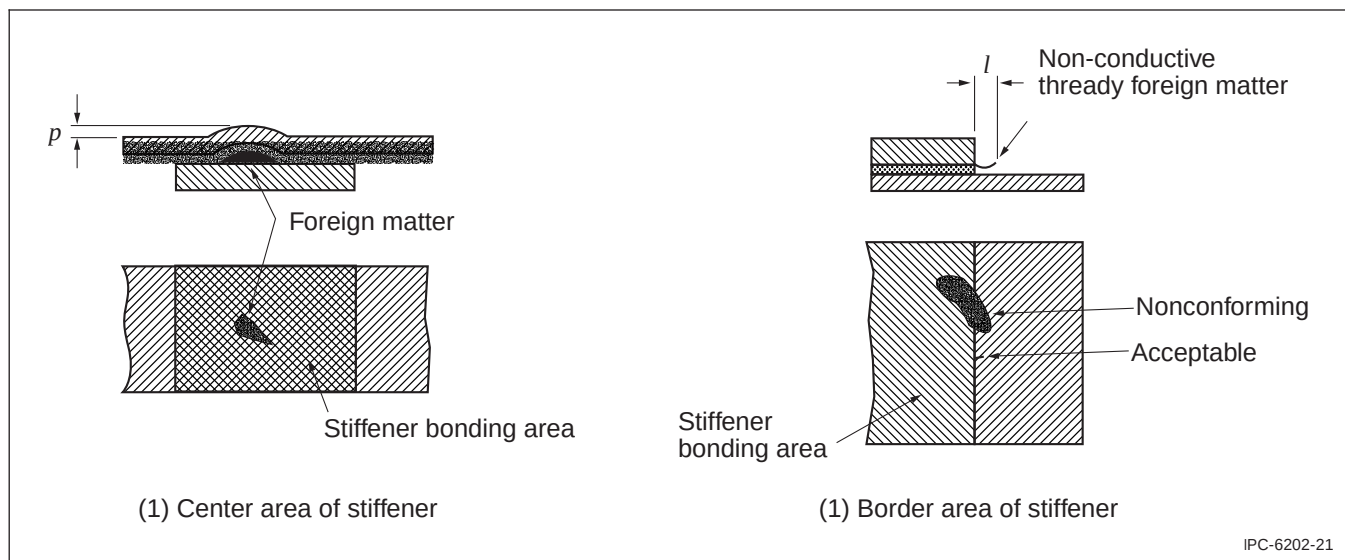


Figure 21 Foreign Matter Between Board and Stiffener

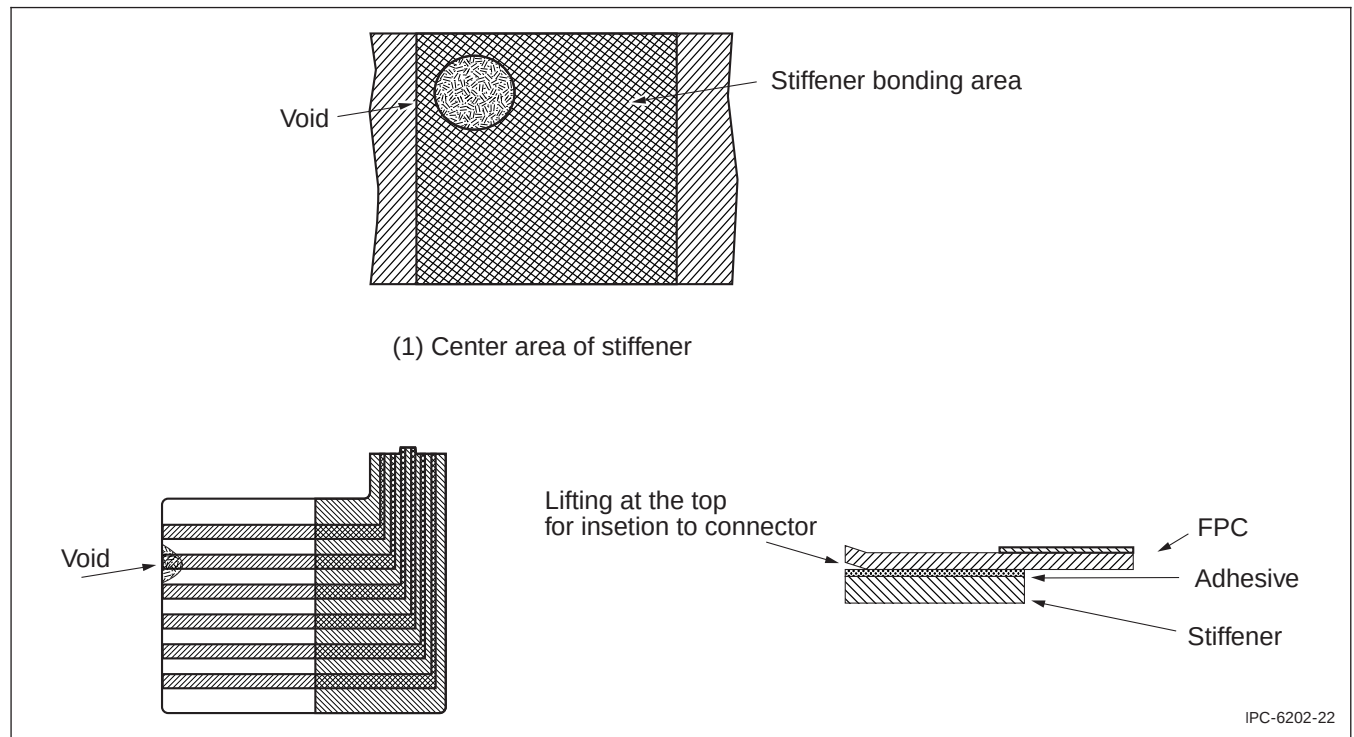


Figure 22 Voids Between Board and Stiffener

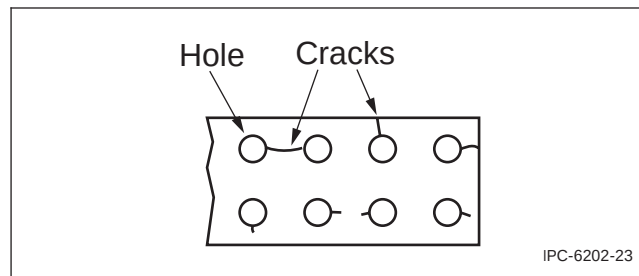


Figure 23 Cracks

Table 21 Cracks

Level	Cracks
1	There shall be no cracks that could affect practical use.
2 and 3	There shall be no crack that links two holes on the stiffener as well as that links a hole and the outline edge.

8 DIMENSIONAL INSPECTIONS

8.1 Measurement of Dimensions Measuring methods for dimensions of the flexible printed board **shall** be in accordance with JIS C 5016, paragraphs 3, 4, 5, and 6.3.

8.2 External dimensions Measurement of external dimensions of the FPC **shall** meet the requirements of Table 26.

8.3 Thickness Thickness **shall** meet the requirements agreed upon between manufacturer and customer.

8.4 Holes Holes **shall** meet the requirements of Table 27.

8.4.1 Component Holes The minimum diameter of component holes **shall** be 0.5 mm, and the tolerance **shall** be ± 0.08 mm.

8.4.2 Vias Plated-through holes used for vias for double-sided FPCs **shall** be made of round holes only and **shall** meet the requirements of Table 28.

8.4.3 Mounting Holes The minimum diameter of round holes **shall** be 0.5 mm, and the tolerance **shall** be $\leq \pm 0.08$ mm or less.

8.5 Conductor Widths Tolerances of the width of finished conductors for designed conductor widths **shall** meet the requirements of Table 29.

8.6 Clearances Between Conductors The tolerance of clearances between finished conductors for the designed conductor clearances **shall** meet the requirements of Table 30.

8.7 Distance Between Hole Centers The distance between hole centers **shall** meet the requirements of Table 31.

8.8 Minimum Distance Between Board Edges and Conductors The minimum distance between board edges and conductors **shall** meet the requirements of Table 32.

8.9 Positional Accuracy

8.9.1 Positional Accuracy of Holes Positional tolerance of finished holes to the design position data **shall** be $\leq \pm 0.3\%$, excluding via holes.

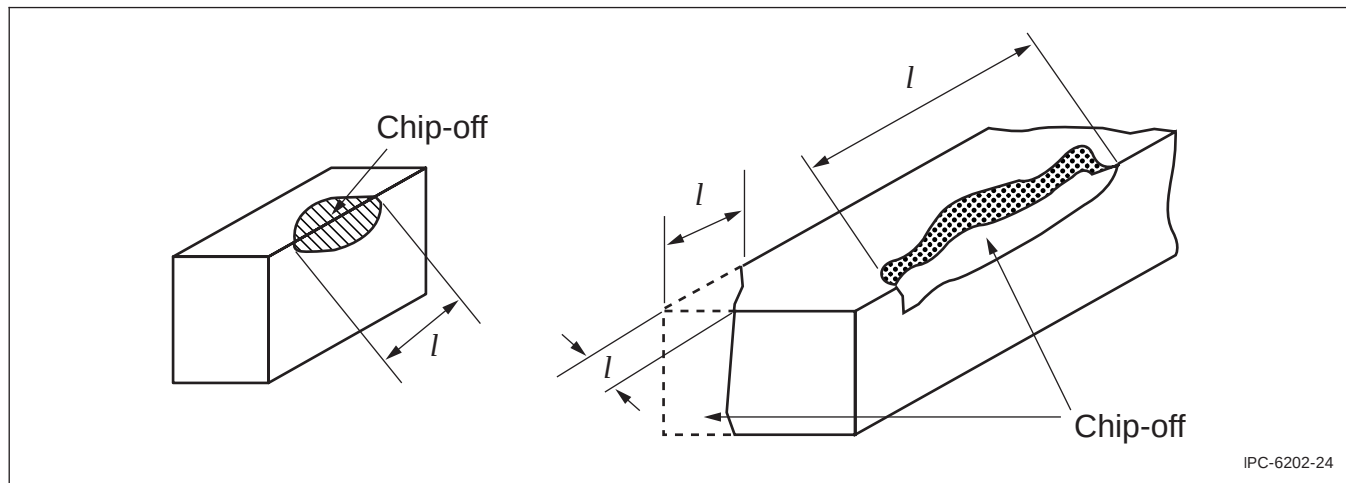


Figure 24 Chip-Off

Table 22 Thermosetting Adhesives on Surface

Level	Thermosetting Adhesive on Surface
1 and 2	Cured adhesives, chips of coverlay, covercoat, or fibers stuck with adhesive hard on the surface is acceptable, provided they do not fall off when rubbed with an applicator impregnated with isopropyl alcohol. Where total thickness is specified, the thickness including the adhesive on surface shall meet the requirement.
3	There shall be no visible matter stuck with adhesive on surface.

Table 23 Flux Residue on Surface

Level	Thermosetting Adhesive on Surface
1 and 2	When the surface is rubbed with an applicator impregnated with isopropyl alcohol, the applicator shall not be stained with flux residue.
3	There shall be no visible flux residue on surface.

Table 24 Residue of Metal Powders (Solder, Aluminum, Copper, Etc.)

Level	Residue of Metal Powders (Solder Aluminum, Copper, Etc.)
1	Easily removable metal powder (removable within one minute with ultrasonic cleaning) is acceptable. The acceptable size and the number of metal powders shall be as follows: For 0.1 mm less than or equal to the powder diameter <0.3 mm: three or fewer per product. For 0.05 mm less than or equal to the powder diameter <0.1 mm: 10 or fewer per product.
2	There shall be no visible metal powder residue.
3	There shall be no metal powder residue detectable with magnification 10X.

Table 25 Residue of Adhesive

Level	Residue of Adhesive
1 and 2	The acceptable size and the number of adhesive residues shall be as follows: For 1.0 mm less than the size of adhesive <2.0 mm: one or fewer per product. For 0.1 mm less than the size of adhesive <1.0 mm: five or fewer per product.
3	There shall be no visible adhesive residue.

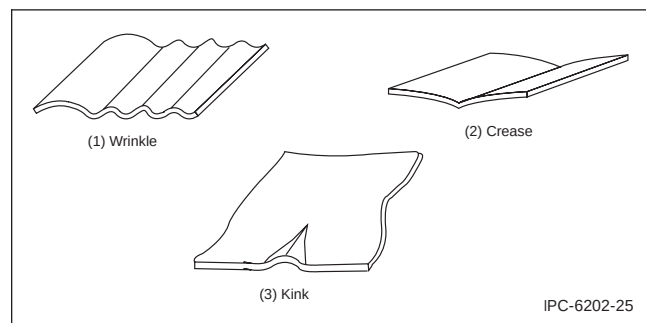


Figure 25 Protrusions and Dents on Flexible Printed Board

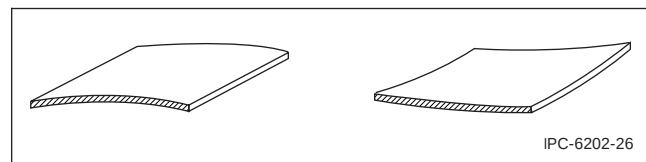


Figure 26 Bow and Twist

8.9.2 Registration of Hole to Land The minimum solderable land width (q) of finished lands shown in Figure 27 **shall** be ≥ 0.05 mm.

8.9.3 Registration of Coverlay (or Covercoat) to Land

The covering (r) of coverlay (or covercoat) on the land caused by misregistration, as shown in Figure 28, **shall** be $\leq \pm 0.3$ mm for an external dimension <100 mm, and **shall** be $\leq \pm 0.3\%$ of the external dimension for an external dimension of ≥ 100 mm.

Table 26 Tolerance of External Dimension

Level	Tolerance of External Dimension
1 and 2	Tolerance of the external dimension of the product: For product size smaller than 100 mm: ± 0.30 mm For product size 100 mm or larger: $\pm 0.3\%$
3	Requirements shall be agreed between manufacturer and customer.

Table 27 Requirements for Holes

Level	Requirement for Holes
1 and 2	Paragraphs 8.4.1, 8.4.2, and 8.4.3 shall apply.
3	When the requirements exceed the scope of paragraphs 8.4.1, 8.4.2, and 8.4.3, the requirements shall be agreed upon by manufacturer and customer.

Table 28 Requirements for Vias

Level	Requirement for Vias
1	Minimum hole diameter after plating shall be 0.5 mm, and the tolerance shall be $\leq \pm 0.08$ mm.
2	Minimum hole diameter after plating shall be 0.4 mm, and the tolerance shall be $\leq \pm 0.08$ mm or less.
3	The requirements shall be agreed between manufacturer and customer.

Table 29 Conductor Widths and Tolerances (mm)

Designed Conductor Width	Tolerance
≤ 0.10	$\leq \pm 0.050$
≥ 0.10 and < 0.30	$\leq \pm 0.08$
≥ 0.30 and < 0.50	$\leq \pm 0.10$
≥ 0.50	$\leq \pm 20\%$

Table 30 Conductor Clearances and Tolerances (mm)

Designed Conductor Clearance	Tolerance
≤ 0.10	$\leq \pm 0.05$
≥ 0.10 or ≤ 0.30	$\leq \pm 0.08$
≥ 0.30	$\leq \pm 0.1$

Table 31 Tolerance of Distance Between Hole Centers

Level	Tolerance of Distance Between Hole Centers
1 and 2	Tolerance for distance < 100 mm shall be $\leq \pm 0.30$, and for distances of ≥ 100 mm, shall be $\leq \pm 0.3\%$ of the distance between hole centers.
3	The requirements shall be agreed upon between manufacturer and customer.

8.9.4 Registration of Stiffener to FPC

8.9.4.1 Registration of Holes The discrepancy (s) between holes of the stiffener and the flexible printed circuit, as shown in Figure 29, **shall** not reduce the hole diam-

Table 32 Minimum Distance between Board Edges and Conductors

Level	Minimum Distance between Board Edges and Conductors
1 and 2	The minimum distance between board edges and conductors shall not be < 0.5 mm
3	The requirements shall be agreed upon between manufacturer and customer.

eter of the printed circuit or stiffener, whichever is smaller, by 0.3 mm or more. At the same time, the difference (D - s) between the hole diameter (D) and the discrepancy (s) **shall** meet the tolerance requirement for the hole diameter (D).

8.9.4.2 Registration of Outlines The discrepancy (j) between outlines of the stiffener and the FPC, as shown in Figure 30, **shall** meet the requirements of Table 33.

8.9.5 Registration of Punched Outline to Conductor Patterns The registration of punched outline to conductor patterns **shall** meet the requirements of Table 34.

8.10 Registration of Pressure Sensitive or Heat Activated Adhesives (Including Adhesive Squeeze-Out) to Flexible Printed Board and Stiffener The discrepancy (v) of pressure sensitive or heat activated adhesives from the FPC and stiffener (including adhesive squeeze-out), as shown in Figure 31, **shall** be $\leq \pm 0.50$ mm. The registration of adhesives at component holes **shall** meet the requirements for the tolerance of the hole diameter.

8.11 Plating Thickness of Copper Plated-Through Holes The plating thickness of copper plated-through holes **shall** be 0.015 mm on average, and the minimum thickness **shall** be 0.008 mm.

9 TESTING OF ELECTRICAL PERFORMANCE

The electrical performance of the FPC **shall** be tested in accordance with JIS C 5016. The test items and requirements are shown in Table 35.

10 TESTING OF MECHANICAL PERFORMANCE

The mechanical performance of FPCs **shall** be tested in accordance with JIS C 5016. The test items and specifications are shown in Table 36.

11 ENVIRONMENTAL PERFORMANCE

The environmental testing of FPCs **shall** be performed in accordance with JIS C 5016. The test items and requirements are shown in Table 37.

12 MIGRATION

The requirements for migration **shall** be agreed upon by manufacturer and customer.

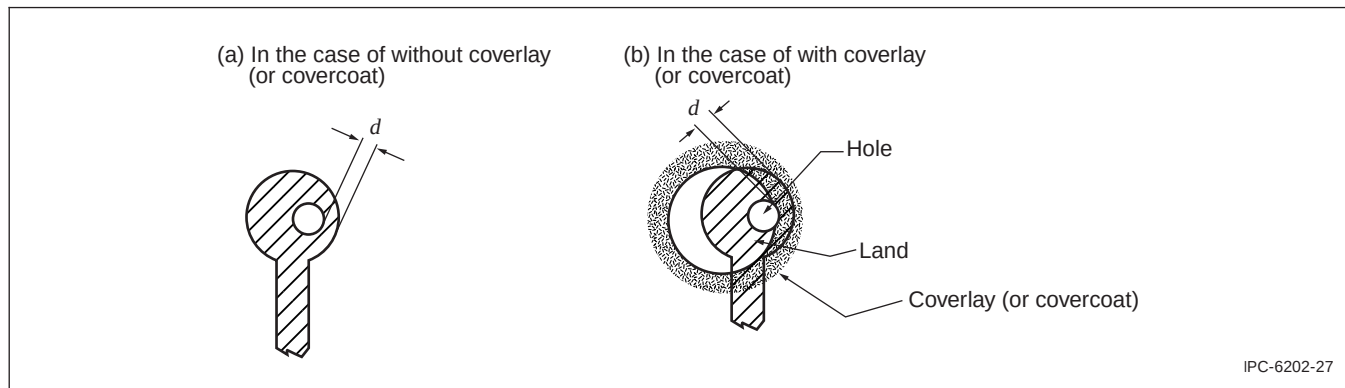


Figure 27 Misregistration of Hole and Land

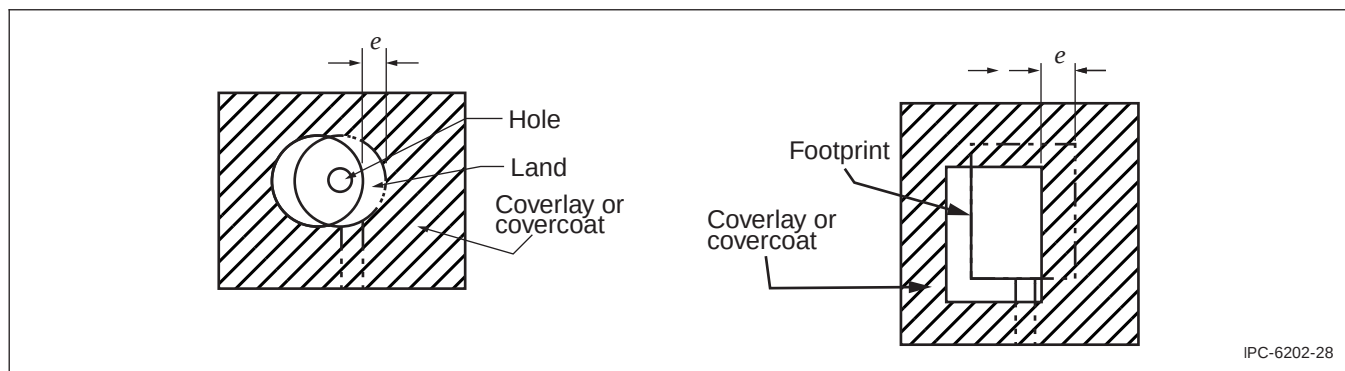


Figure 28 Misregistration of Land and Coverlay (or Covercoat)

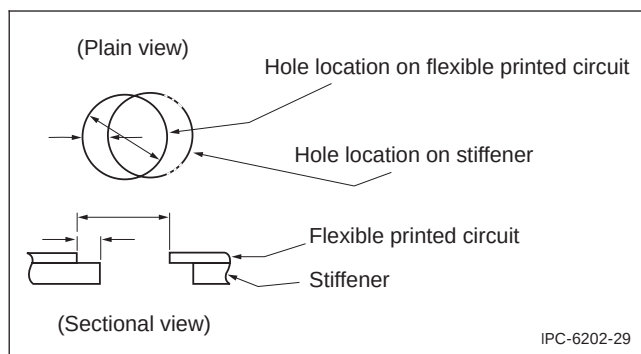


Figure 29 Registration of Holes

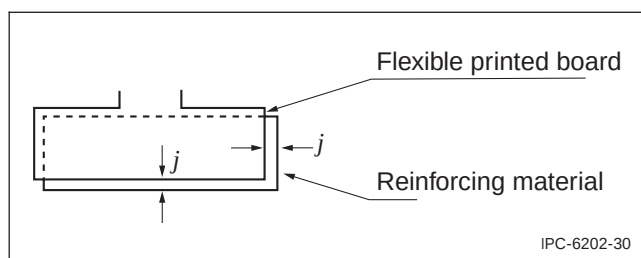


Figure 30 Registration of Outlines

13 CHEMICAL RESISTANCE

There **shall** be no swell or delamination when tested in accordance with JIS C 5061, paragraph 10.5. Also, there **shall** be no significant damage of symbol marks.

Table 33 Allowable Misregistration of Outlines

Level	Tolerance
1	$\leq \pm 0.5 \text{ mm}$
2	$\leq \pm 0.3 \text{ mm}$
3	$\leq \pm 0.2 \text{ mm}$

Table 34 Registration of Punched Outline to Conductor Patterns

Level	Requirements for Registration
1 and 2	The edges of the board outline shall not be in contact with conductors, except for plating lead(s), isolated land(s), and conductor(s) for mechanical reinforcement.
3	The clearance between the outline edges and the conductors shall be $\geq 0.1 \text{ mm}$.

14 CLEANLINESS

Extract with a mixture of 75% isopropyl alcohol and 25% distilled water, measure the electrical conductance of the extract, and convert the measured value into the chlorine/ion concentration. A FPC **shall** not contain more than 1.2 μg of chlorine ion per 1 cm of the printed board.

15 FLAME RESISTANCE

Flame resistance **shall** be tested in accordance with JIS C 6471, paragraph 9.1 (Flame Resistance). A FPC **shall** meet the requirements of JIS C 5017, paragraph 3, item 10.

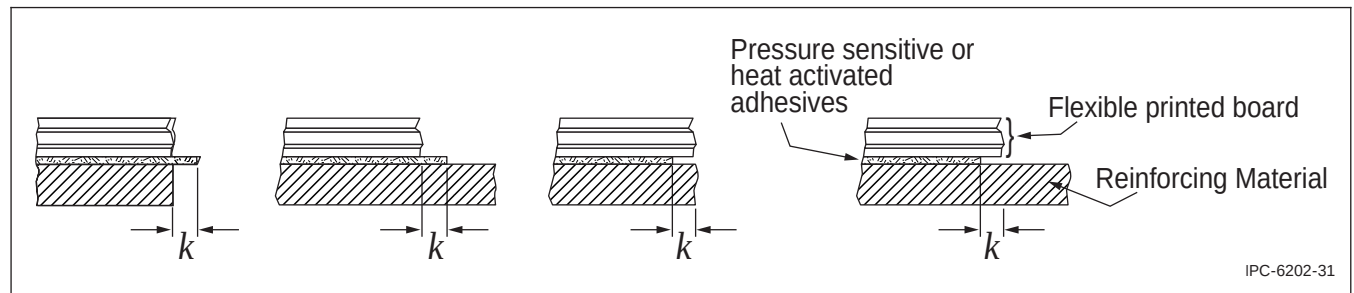


Figure 31 Registration of Pressure Sensitive or Heat Activated Adhesives from Flexible Printed Board and Stiffener (Including Adhesive Squeeze-Out)

Table 35 Electrical Properties of Flexible Printed Boards

Item No.	Item		Requirements	Test Method (JIS C 5016)
9.1	Conductor resistance		Shall be agreed upon by manufacturer and customer	Per paragraph 7.1 (Conductor resistance)
9.2	Insulation resistance of surface layers	As received	$\geq 5 \times 10^8 \Omega$	Per paragraph 7.6 (Insulation resistance, surface layers)
		After humidity test	Level 1: shall retain the electrical functions Level 2: $\geq 1 \times 10^8 \Omega$ Level 3: $\geq 5 \times 10^8 \Omega$	Per paragraph 9.4 (Temperature and humidity cycling test)
9.3	Dielectric withstanding voltage of surface layers		There shall be no flashover when 500 V ac is applied.	Per paragraph 7.5 (Dielectric withstanding voltage, surface layers)
9.4	Open circuit		The resistance > 5 ohms shall be decided as "Open"*.	Per paragraph 7.7.2 (Circuit continuity test)
9.5	Short circuit		The resistance < 2 megohms shall be decided as "Open"*.	Per paragraph 7.7.1 (Circuit isolation test)

* Not necessarily consistent with the threshold values of test equipment used for judging product performance

Table 36 Mechanical Properties of Flexible Printed Boards

Item No.	Item		Property Requirements	Test Method (JIS C 5016)
10.1	Peel strength	Conductors	≥ 0.49 N/mm	Per paragraph 8.1 (Peel strength)
		Coverlay	≥ 0.34 N/mm	Specimens bonded on the shiny side of the copper foil having a width of 10 mm shall be tested in accordance paragraph 8.1, method B.
		Stiffeners	Thermosetting adhesives: 0.34 N/mm Pressure sensitive adhesives: ≥ 0.15 N/mm	Specimen bonded on the base film having a width of 10 mm shall be tested in accordance with paragraph 8.1, method B.
10.2	Pull-out strength for plain holes and footprints		Level 1: Not specified Level 2 and 3: ≥ 0.34 N/mm	Per paragraph 8.2 (Pull-out strength for plain holes) and 8.3 (Pull-out strength for footprints)
10.3	Plating adhesion		There shall be no plating portion removed.	Per paragraph 8.4 (Plating adhesion)
10.4	Solderability		The well-wetted area shall be more than 95% of the total coated area. This does not apply to FPCs with polyester base film.	Per paragraph 10.4 (Solderability)
10.5	Flexural endurance		FPCs with coverlayer shall endure repeated flexing with the radius and rate of flexing agreed upon by manufacturer and customer.	Per paragraph 8.6 (Flexural endurance) The rate of 1000 cycles/minute or higher is preferable to save time for the test.
9.4	Bending resistance		The FPC with coverlayer shall endure repeated bending with the radius, load, and number of bending cycles agreed upon by manufacturer and customer.	Per paragraph 8.7 (Bending resistance)

Table 37 Environmental Tests and Requirements

Item No.	Item		Requirements	Test Method JIS C 5016
11.1	Temperature cycling		Shall meet the requirements before and after the tests for the items and conditions agreed upon by manufacturer and customer	Per paragraph 9.1 (Temperature cycling)
11.2	Humidity test	Stationary condition	Same as 11.1	Per paragraph 9.5 (Humidity test, stationary condition)
		Temperature/humidity cycling	Same as 11.1	Per paragraph 9.4 (Humidity test, temperature/humidity cycling)
11.3	Thermal shock	High temperature dipping	Same as 11.1	Per paragraph 9.3 (Thermal shock, low temperature/high temperature cycling)
		Low temperature/high temperature cycling	Same as 11.1	Per paragraph 9.2 (Thermal shock, low temperature/high temperature cycling)
11.4	Thermal shock resistance of copper plated-through holes		The change in resistance of plated-through holes shall not exceed 20%.	Per paragraph 10.2 (Thermal shock resistance of copper plated-through holes)

16 MARKING, PACKAGING, AND STORAGE

These should normally be agreed upon by manufacturer and customer. The items in 16.1 and 16.2 are given just as guidelines.

16.1 Marking on Products

- (1) Product name or product's code name
- (2) Name of manufacturer or manufacturer's code name

16.2 Marking on Package

- (1) Product type (name or symbol expressing the FPC **shall** be marked where it is readily seen)
- (2) Product name or product's code name
- (3) Number of products in the package
- (4) Production lot number or year/month of manufacturing
- (5) Name of manufacturer or its code name

16.3 Packaging and Storage

16.3.1 Packaging Packaging **shall** meet the requirements of Table 38.

Table 38 Requirements for Packaging

Level	Requirements
1	Product shall be packaged so that the product may not be damaged during transportation.
2	In addition to the requirement for level 1, humidity shall be controlled during storage at room temperature.
3	In addition to the requirement for level 2, any requirements agreed upon by manufacturer and customer shall be incorporated.

16.3.2 Storage FPCs **shall** be stored in a room that is equipped with a suitable humidity-controlling device.

16.3.3 Handling An example of a handling instruction manual is shown in the following. This example has been written for the purpose of preventing accidents caused by the handling of FPCs by customers.

Appendix I

Example of Handling Instruction Manual

Handling of Polyimide-Based FPC

1 STORAGE AND HANDLING

Wipe off moisture and/or chemical substance(s) that have attached to the product surface during storage and/or handling. These substances may cause discoloration and/or deterioration of the product.

The tarnish protection coating on conductors is valid for approximately six months after production in a room where temperature and humidity are controlled, whereas the plated and cream-solder-coated surface is valid for approximately one year.

2 COMPONENT MOUNTING AND INSTALLATION TO EQUIPMENT

Power to tighten screws and caulk metal plates **shall** be appropriately adjusted. Too intensive power may break the materials.

3 SOLDERING

3.1 Pre-Treatment Polyimide used as a base film for FPCs and as a coverlay readily absorbs moisture (i.e., the simple film is saturated in approximately four hours). This may readily cause blistering of the FPC by a rapid temperature change when you carry out soldering using a reflow furnace or a flow soldering equipment. Pre-drying of the FPC to remove the absorbed moisture should be added as a pre-treatment process before the component assembly process.

Depending on the composition of the FPC, the following pre-drying conditions at Appendix Table 1 are recommended:

The difference in drying time depending on the composition of FPC or patterns is caused by the difference in moisture removal time from polyimide and/or adhesive layers. Pre-dried FPCs, when left in a normal environment (air-conditioned room), should be soldered within the same day. If soldering is to be carried out the next day, the FPC should be stored in a moisture-tight bag. Put silica gel, which can prolong the allowable time for soldering to approximately one month (the period may vary depending on the type of bag), in the bag and seal. When you carry out manual soldering or flow soldering, after leaving the FPC for one or more days after reflowing, one hour or more of pre-drying should be added.

3.2 Soldering When the soldering temperature is too high or soldering time is too long, separation or blistering of the FPC may occur. Also, if the FPC is bent or pressed too much with an iron while being heated, the land may separate. Suitable soldering conditions must be selected according to the circuit pattern and the working location.

Be careful not to burn yourself while soldering. Protection such as goggles should be worn to prevent burning by scattered fine solder balls and flux.

4 DISPOSAL

Disposal must be carried out according to the specified way of disposing industrial wastes. Do not incinerate or dump wastes underground or in the sea without permission.

Appendix Table 1 Recommended Pre-Drying Conditions

FPC	Pattern Composition	Stiffener Material	Pre-drying Temperature	Drying Time
Single-side	Fine patterns only (such as signal lines)	None	80°C	≥ 30 minutes
		Film	80°C	≥ One hour
		Glass/epoxy board, etc.	120°C	≥ One hour
Double-sided	Fine patterns only (such as signal lines)	None	80°C	≥ 30 minutes
		Film	80°C	≥ One hour
		Glass/epoxy board, etc.	120°C	≥ One hour
	With wide patterns (such as ground lines)	None	120°C	≥ 30 minutes
		Film	120°C	≥ One hour
		Glass/epoxy board, etc.	120°C	≥ Two hours

Appendix II

Explanation on JPCA Performance Guide Manual for Single- and Double-Sided Flexible Printed Wiring Boards

This explanation does not constitute a part of this specification, but is just to help the reader understand what is written in the text and the related issues.

I. Way to completion of this document In 1992, we prepared JPCA-FC03, "Specification for External Appearance of Flexible Printed Wiring Boards," to establish the requirements for the external appearance of the FPC, which had not been specified at that time. The purpose of that standard was:

- To specify the most common external appearance
- To avoid unnecessary disputes generating from the difference of concepts between the manufacturer and customer on the external appearance of FPCs
- To pursue cost performance
- To further advance the technology of FPCs
- To fulfil the consumers' expectations

The content of this standard was succeeded by JIS C 5017, "Single- and Double-Sided Flexible Printed Wiring Boards," which was prepared in 1994.

JPCA Performance Guide Manual prepared this time is a step to the final IEC Standard, which is to be prepared based on the preliminary documents mentioned above. At the draft stage, we adopted the style of IEC 326-7 and IEC 326-8, and also referenced IPC Standards, particularly IPC-FC-250. The overall constitution of this standard, therefore, followed that of the IEC Standards. The most difficult was the "classification." There was no idea of "classification" in JPCA-FC03 and JIS C 5017, whereas the idea of "classification" was essential for an IEC Standard. On the other hand, the classification in conventional standards, including IPC, was based on the characteristics of the printed board, and the classification was applied uniformly to all the items of the printed board. This sometimes compelled a certain application that could be met with a regular class into a higher class, which was quite impractical.

In the present document, the term "class" has been changed to "level," which is based on the level of the required performance only. In principle, the whole product can be assigned Level 1, Level 2, or Level 3, while we decided that each specification item can also be assigned one of these levels from the more practical standpoint. This may be an unusual concept as a standard; thus, we also changed the name of this document to "performance guide manual" so that it can be applied more flexibly.

II. Supplemental Explanation on Each Specification
(The item numbers are those in the text.)

5 PERFORMANCE LEVELS: CLASSIFICATION OF SPECIFICATION ITEMS AND APPLICATION OF PERFORMANCE LEVELS

Since the FPC is a type of the printed board, the classification of specification items of this performance guide is in accordance with the IEC Standards for printed boards. This is done so the classification is in harmony with the conventional JIS Standards and with international standards in future.

On the other hand, FPCs for different objectives require different performance items, and only a particular portion of a printed board often requires a higher level of performance.

For example, a FPC used for an application where the printed board is subject to repeated flexing sometimes requires a special specification, such as, "There **shall** be no dents and nicks in flexing portion."

Other remarkable requirements and applications for FPCs are as follows:

1. Dimensions (for fine circuit patterns for fine connections)
2. Flexural performance (for applications such as hard disks, floppy disks, and printers, which are repeatedly flexed)
3. Cleanliness (including hard disk contamination issue)
4. Surface treatment (for FPCs mounting COF components)

As seen from the items above, the FPC is unique in its overall dependency in quality (reliability) and cost on specific requirements. Consequently, each FPC can't have only one overall "level," whereas each specification item has its own "level," and we can select a specific portion with a certain "level" different from other portions of the same FPC to use it for a certain application.

7.5.1.2 Nicks and Pinholes on Conductors These are used to judge if the FPC can be used without any trouble in its function (e.g., at the time of component mounting and/or soldering).

We added requirements for defects on lands, since troubles actually occur there and no requirement has been specified to date. The value 10% used in the specification is the

common value, which has been used in the agreement of manufacturers and customers.

7.5.1.3 Extraneous Copper Between Conductors and Spurs and Nodules of Conductor in Open Area We added requirements for this item, since this is the phenomenon actually occurring. The value 0.125 mm was specified, assuming there is no problem on electrical properties.

7.5.3.4 Foreign Matters In the conventional specifications, a non-conductive foreign matter has been assumed to never cross over three patterns, whereas the assumption is no more practical for the dense patterns currently used, so we changed the specification to absolute sizes.

7.5.4.1.1 Gold Plating The item for wire bonding use was added.

8.2 External Dimensions External dimensions were changed to meet the current levels.

14 CLEANLINESS

Non-volatile residues (NVR), organic silicone, and ion contamination (including chlorine) are the new problems for hard-disk drives (HDDs); thus, the manufacturer and customer are reaching agreements to carry out analyses based on FTIR and ion chromatography.

16.3.2 Storage Pre-drying conditions after storage were clearly indicated to maintain the heat resistance in soldering.

Appendix III

Japanese Industrial Standard (JIS) Test Methods

- JIS C 5016-1994** Test Methods for Flexible Printed Wiring Boards
- JIS C 5017-1994** Flexible Printed Wiring Boards - Single-Sided, Double-Sided
- JIS C 5603-1993** Terms and Definitions for Printed Circuits
- JIS C 6471-1995** Test Methods for Copper-Clad Laminates for Flexible Printed Wiring Boards
- JIS C 6472-1995** Copper-Clad Laminates for Flexible Printed Wiring Boards (Polyester Film, Polyimide Film)
- JIS C 6512-1992** Electrodeposited Copper Foil for Printed Wiring Boards
- JIS C 6513-1996** Rolled Copper Foil for Printed Wiring Boards

JIS C 5016-1994

Test Methods for Flexible Printed Wiring Boards

1 SCOPE

This Japanese Industrial Standard specifies test methods for single- and double-sided flexible printed wiring boards principally used in electronic apparatus, regardless of the manufacturing method (hereafter, referred to as flexible printed boards).

Remarks Multilayer flexible printed boards and flex-rigid printed boards are excluded from this Standard.

1.1 Cited Standards

JIS B 7153	Toolmaker's Microscopes
JIS B 7503	Dial Gauges
JIS B 7507	Vernier, Dial and Digital Calipers
JIS C 0010	Environmental Testing Part 1: General and Guidance
JIS C 0022	Basic Environmental Testing Procedures Part 2: Tests, Test Ca: Damp Heat, Steady State
JIS C 0028	Basic Environmental Testing Procedures Part 2: Tests Test Z/AD: Composite Temperature/Humidity Cyclic Test
JIS C 1102	Electrical Indicating Instruments
JIS C 1303	High Insulation Resistance Meters
JIS C 2110	Testing Methods for Electric Strength of Solid Insulating Materials
JIS C 5603	Terms and Definitions for Printed Circuits
JIS C 6471	Test Methods of Copper-Clad Laminates for Flexible Printed Wiring Boards
JIS K 5902	Colophonium
JIS K 8101	Ethanol (99.5) (Ethyl Alcohol (99.5))
JIS K 8839	2-Propanol
JIS Z 1522	Pressure Sensitive Adhesive Cellophane Tapes
JIS Z 3282	Soft Solder
JIS Z 3283	Resin Flux Cored Solders

1.2 International Standards

IEC 249-1 (1982)	Base Materials for Printed Circuits Part 1: Test Methods
IEC 326-2 (1990)	Printed Boards Part 2: Test Methods

2 DEFINITIONS

For the main terms used in this Standard, the definitions in JIS C 0010 and JIS C 5603 apply.

3 ATMOSPHERIC CONDITIONS FOR TESTING

3.1 Standard Conditions Unless otherwise specified in the detailed specification, the tests shall be carried out under the standard atmospheric conditions specified in 5.3 of JIS C 0010 (150°C to 35°C, 25% RH to 75% RH, and air pressure 86 kPa to 106 kPa). If there is any dispute on the decision based on these standard conditions, or if there are any special requirements, the conditions of 3.2 shall be employed.

If it is difficult to carry out the tests under the standard conditions, the tests may be carried out under atmospheric conditions other than the standard conditions unless any dispute arises on the decision.

3.2 Referee Conditions The referee conditions shall be the atmospheric conditions for referee tests specified in 5.2 of JIS C 0010 (temperature 20°C ± 20°C, 60% RH to 70% RH, and air pressure 86 kPa to 106 kPa).

4 SPECIMEN

4.1 Preparation of Specimen The specimens shall be prepared as specified in 4.1.1 or 4.1.2.

Care shall be taken not to make the surfaces of the specimens dirty (i.e., oils, sweat, etc.) during handling.

4.1.1 Method by Sampling The specimens shall be sampled from flexible printed boards for actual use. If the shape and dimensions are specified in the detailed specification, the sampled ones shall be cut so the performances are not affected.

If test coupons are provided, they may be used as the specimens.

4.1.2 Method by Test Pattern The specimens complying to the test pattern of 4.2 shall be prepared from the same material and by the same manufacturing method as those of the flexible printed boards intended to be tested.

4.2 Shape and Dimensions of Test Pattern The shape and dimensions of the test pattern shall be as illustrated in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, and Figure 8.

5 PRECONDITIONING

The specimens shall be allowed to stand under the standard conditions for 24 hours ± 4 hours, for preconditioning.

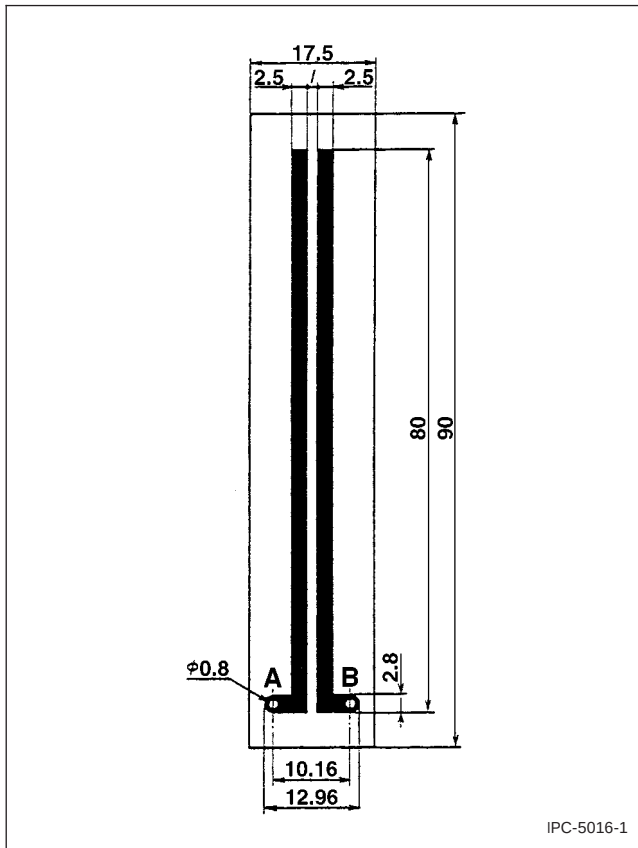


Figure 1 Specimen for Voltage Proof and Insulation Resistance

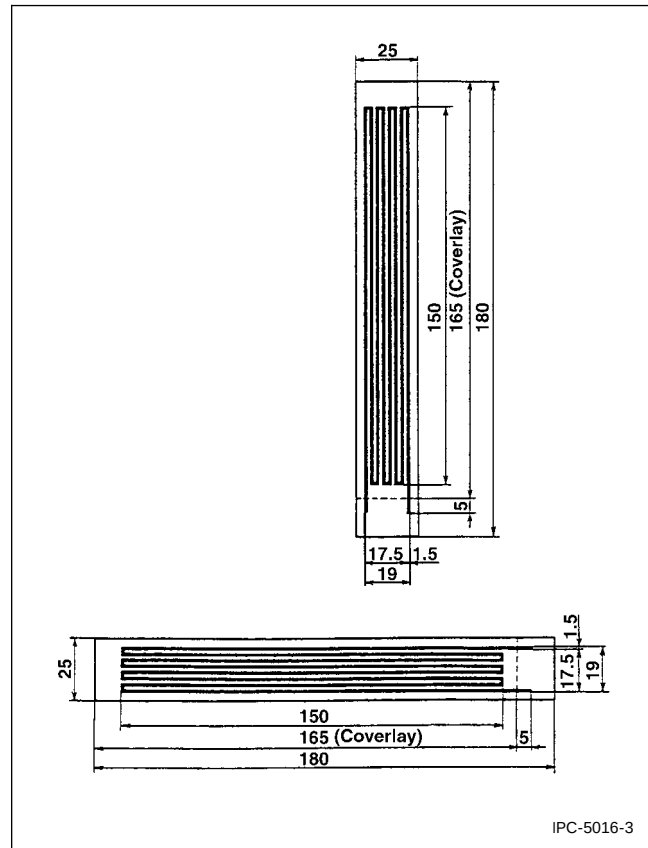


Figure 3 Sample for Resistance to Flexure

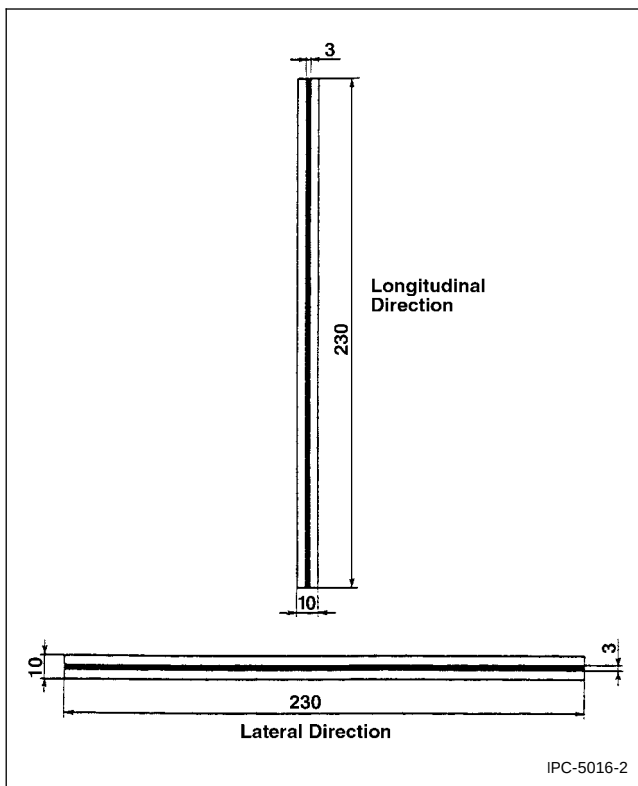


Figure 2 Specimen for Peel Strength

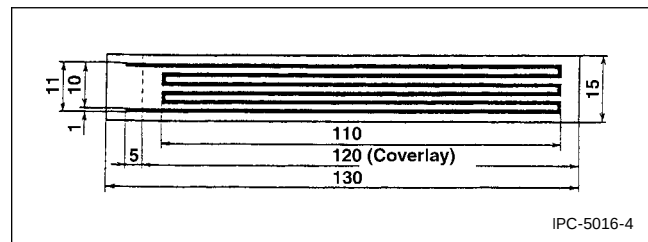


Figure 4 Specimen for Resistance to Fold

6 TESTS FOR APPEARANCE, MICROSECTION, AND DIMENSIONS

6.1 Appearance In the appearance test, confirm the kind of flexible printed board and examine the appearance, finishing, pattern, etc. by comparing it with the detailed specification with the naked eye or by means of a magnifier with a magnification 3X to 10X.

In the case of observing the finished state of the specimen used for the microsection, it is recommended to embed the specimen in epoxy or polyester resin, set the resin, cut the part of the specimen to be observed, grind the cut surface, then examine the ground surface by using a microscope with a magnification of approximately 250X.

6.2 Microsection In the microsection test, examine the plated-through hole (PTH), conductor, internal conditions, appearance, dimensions, etc. in accordance with the detailed specification.

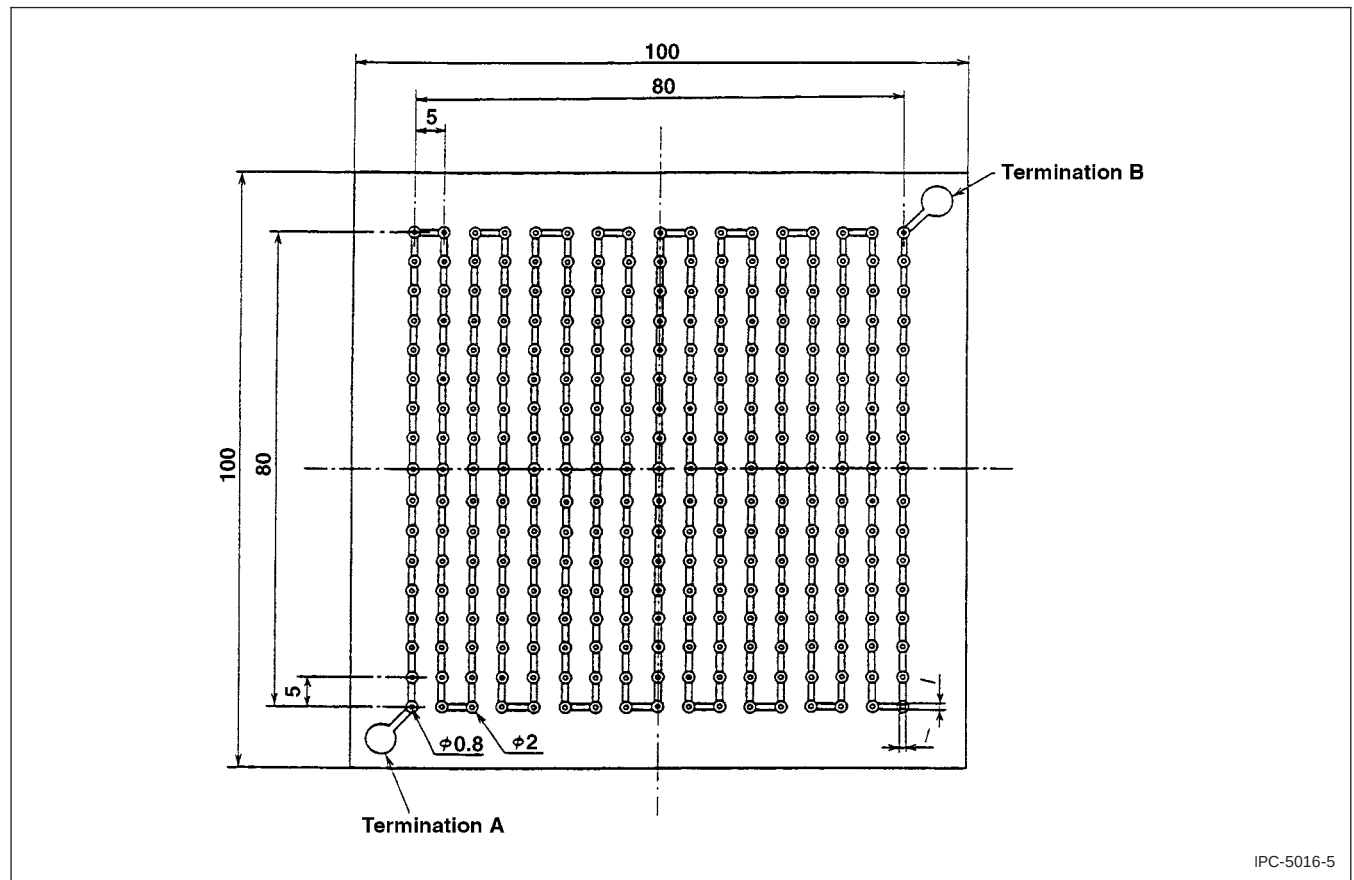


Figure 5 Specimen for Electrical Resistance and Current Proof of Plated-Through Hole and for Resistance to Thermal Shock of Copper Plated-Through Hole

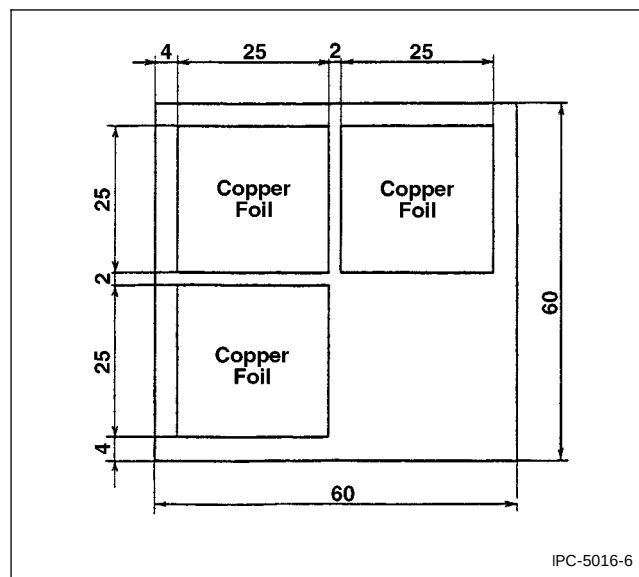


Figure 6 Specimen for Resistance to Solder Heat and Resistance to Chemical (for base material, cover lay and cover coat)

6.2.1 Equipment A grinder and a microscope with a specified magnification range from 100X to about 1000X shall be used as the equipment.

The microscope shall be capable of measuring the thickness of plating, with an accuracy of 0.001 mm or better, or a thickness measuring apparatus at least equivalent in accuracy.

6.2.2 Materials The material shall be mold release agents, patting resins, abrasive cloth (#180, #400, #1000, etc.), abrasive paper (#180, #400, #1000, etc.), and abrasives (almina, chromium oxide, etc.).

6.2.3 Preparation of Specimen The sample shall be carefully cut in an adequate size, not to give damage on the observing portion, and patted using a suitable patting resin. Coarse grinding of the specimen shall be carried out by using the abrasive cloth or paper, starting from coarse grain size then moving to finer ones. Fine grinding shall then be carried out on the felt of a rotary grinding machine with the abrasive poured. The polished surface shall fall within 85° to 95° to the layer.

When the thickness of plating in a through hole is measured, the diameter of the hole appearing on the microsection shall not be <90% of the diameter of the hole previously measured.

If it is necessary to make the boundary of the plating clear, etching shall be carried out after the grinding.

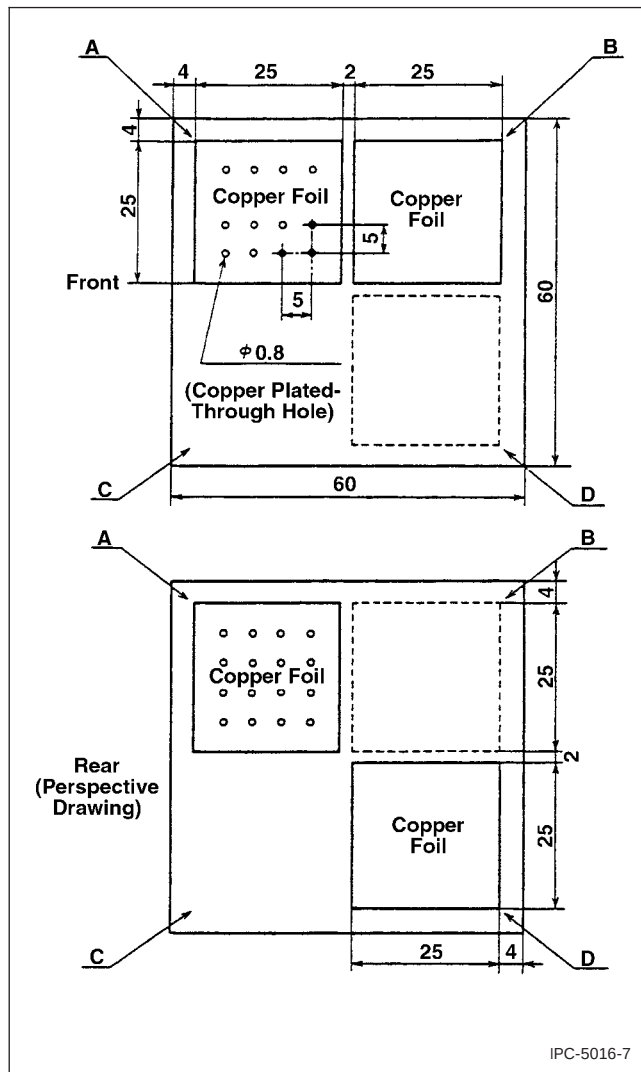


Figure 7 Specimen for Resistance to Soldering Heat and Resistance to Chemical (for base material, coverlay and covercoat)

6.2.4 Test In the test, examine the specified items in the detail specification with a microscope of a specified magnification.

6.3 Dimension Test

6.3.1 Outline

6.3.1.1 Equipment The equipment shall be the toolmaker's microscope specified in JIS B 7153 or equivalent.

6.3.1.2 Measurement Measure the length and width to the nearest 0.05 mm.

6.3.2 Thickness

6.3.2.1 Equipment The equipment shall be the dial gauge reading in 0.001 mm, as specified in JIS B 7503 or equivalent.

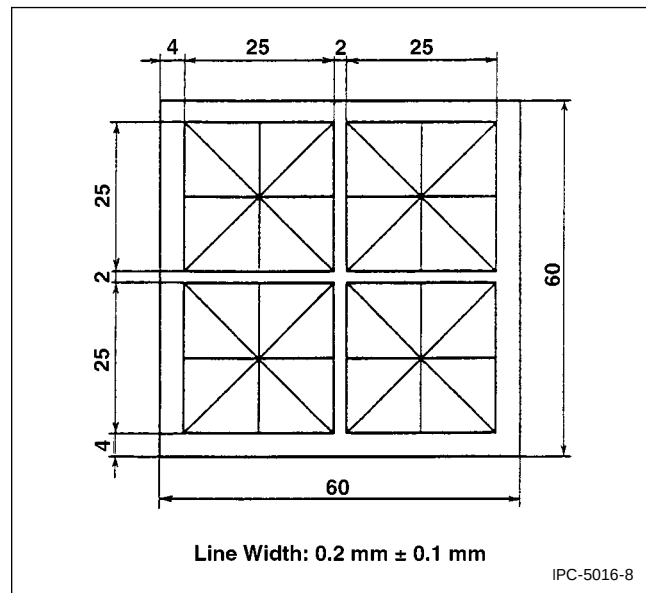


Figure 8 Specimen for Resistance to Soldering Heat and Resistance to Chemical (for symbol marking)

6.3.2.2 Measurement Measure the thickness or total thickness of the specimen to the nearest 0.001 mm.

6.3.3 Diameter of Hole

6.3.3.1 Equipment The equipment shall be a magnifier equipped with a reading scale with an accuracy of 0.01 mm or better or equivalent.

6.3.3.2 Measurement Measure the diameters of the specified holes.

6.3.4 Position of Hole

6.3.4.1 Equipment The equipment shall be a coordinate measuring apparatus or a toolmaker's microscope with an accuracy of 0.01 mm or better or equivalent.

6.3.4.2 Measurement

- (a) To measure the relative position of a hole to the lattice, hold the flexible printed board and measure the distance from the reference hole or reference point on the lattice of the flexible printed board to the hole to be measured along the X and Y axis.
- (b) In the case of measuring the position of a hole from an optional hole, hold the flexible printed board by means of a suitable method for the purpose and measure the distance from the said optional hole to the hole to be measured.

6.3.5 Conductor Width and Minimum Spacing Between Conductors

6.3.5.1 Equipment The equipment shall be a reading micrometer with an accuracy of 0.01 mm or better or equivalent.

6.3.5.2 Measurement Hold the flexible printed board by means of a suitable method and measure the projected dimensions of the conductor width and the minimum spacing between conductors.

6.3.6 Conductor Void and Residual Conductor

6.3.6.1 Equipment The equipment shall be as specified in 6.3.3.1.

6.3.6.2 Measurement Measure the dimensions of the conductor void in the conductor part and those of the residual conductor in the insulation part along the longitudinal and lateral direction of the conductor.

6.3.7 Land Dimensions

6.3.7.1 Equipment The equipment shall be as specified in 6.3.4.1.

6.3.7.2 Measurement Measure the projected dimensions.

6.3.8 Land Width

6.3.8.1 Equipment The equipment shall be as specified in 6.3.4.1.

6.3.8.2 Measurement Measure the projected dimension (w) between the inside wall of the hole and the edge of the land, as shown in Figure 9.

6.3.9 Thickness of Plating of Plated-Through Hole Carry out the measurement on the microsection prepared in accordance with 6.2 using the material specified in Section 4.

6.3.10 Coverlay

6.3.10.1 Equipment The magnifier specified in 6.1 shall be used as the equipment.

6.3.10.2 Specimen The specimen shall be a portion of flexible printed board where the coverlay is applied.

6.3.10.3 Test Using a magnifier, examine the misalignment of the coverlay and the exposed conductor, (i.e., land) for the existence or non-existence of an air gap or foreign matter remaining in the gap between:

- The coverlay and the conductor, or
- The base film and extrusion of coverlay in accordance with the provisions of the detailed specification.

7 ELECTRICAL PERFORMANCE TEST

7.1 Resistance of Conductors

7.1.1 Equipment The equipment shall be the one employing the voltage drop method (four-terminal method) as illustrated in Figure 10 or equivalent. The current shall be a DC current.

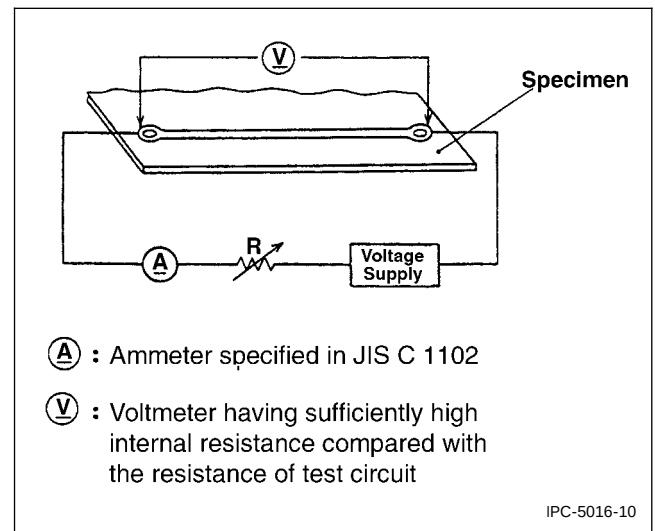


Figure 10 Measuring Equipment of Conductor Resistance

7.1.2 Specimen The specimen shall be a conductor as long and narrow as possible and shall comply with the detailed specification.

7.1.3 Preconditioning The preconditioning shall be as specified in Section 5.

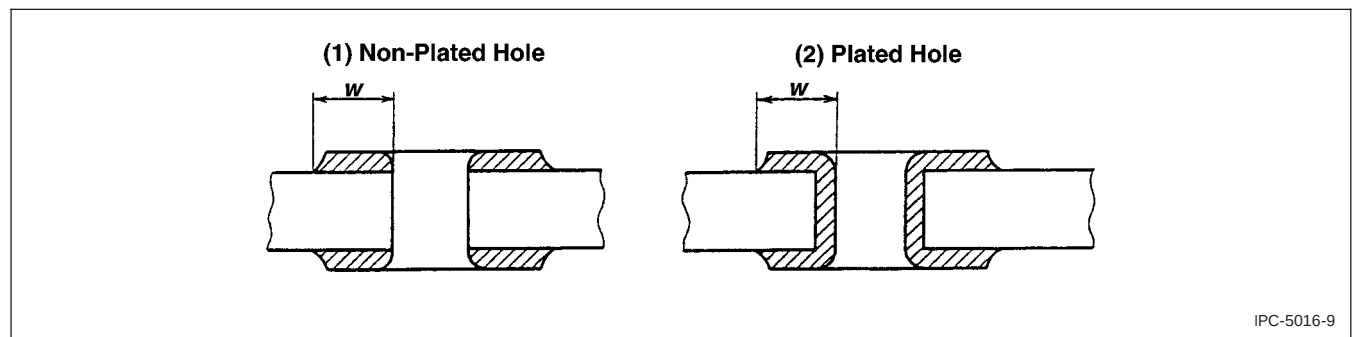


Figure 9 Land Width

7.1.4 Test Take care to avoid the influences due to contacting the method of the probe and heat generation by measuring current, measure the resistance value within $\pm 5\%$ by means of the method shown in Figure 11.

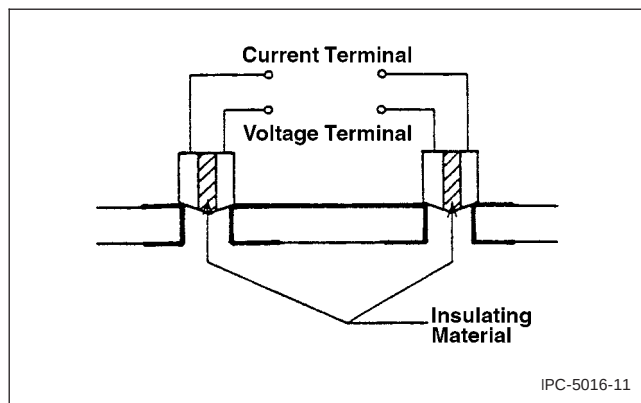


Figure 11 Measuring Method of Conductor Resistance

7.2 Resistance of Plated-Through Hole

7.2.1 Equipment The equipment shall be as specified in 7.1.1.

7.2.2 Specimen The specimen shall be the specified parts of the flexible printed board, test coupon, or the test pattern of Figure 5.

7.2.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.2.4 Test Take care to avoid the influences due to contacting the method of the probe and heat generation by the measuring current, then measure the resistance value within $\pm 5\%$ by the method shown in Figure 12.

7.3 Current Proof of Conductor

7.3.1 Equipment The equipment shall be a DC or AC power supply that can pass the test current of 7.3.4, an ammeter, and a temperature measuring device.

7.3.2 Specimen The specimen shall be the specified part of the conductor in the flexible printed board, test pattern, etc.

7.3.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.3.4 Test Pass the AC or DC current specified in the detailed specification for the specified duration through the specified conductor, then measure the temperature rise.

7.4 Current Proof of Plated-Through Hole

7.4.1 Equipment The equipment shall be a DC or AC power supply that can pass the test current of 7.4.4 and an ammeter.

7.4.2 Specimen The specimen shall be the PTHs of the flexible printed board, test coupon, or the test pattern of Figure 5.

7.4.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.4.4 Test Pass the test current specified in the detailed specification through the PTHs of the specimen continuously for 30 seconds and examine for the existence or non-existence of any abnormality during that period.

An example of the test current versus the diameter of the hole is shown in Table 1.

Table 1 Example of Test Current Versus Hole Diameter

Diameter of hole	mm	0.6	0.8	1.0	1.3	1.6	2.0
Test current	A	8	9	11	14	16	20

7.5 Voltage Proof of Surface Layers

7.5.1 Equipment The equipment shall be the circuit breaker specified in 6.2 (Circuit Breaker) of JIS C 2110 or equivalent.

7.5.2 Specimen The specimen shall be the flexible printed board or the test pattern of Figure 1.

For double-sided flexible printed boards, two kinds of specimens (i.e., one in which the conductor pattern is formed on the front surface and the other having the pattern on the rear surface) shall be prepared.

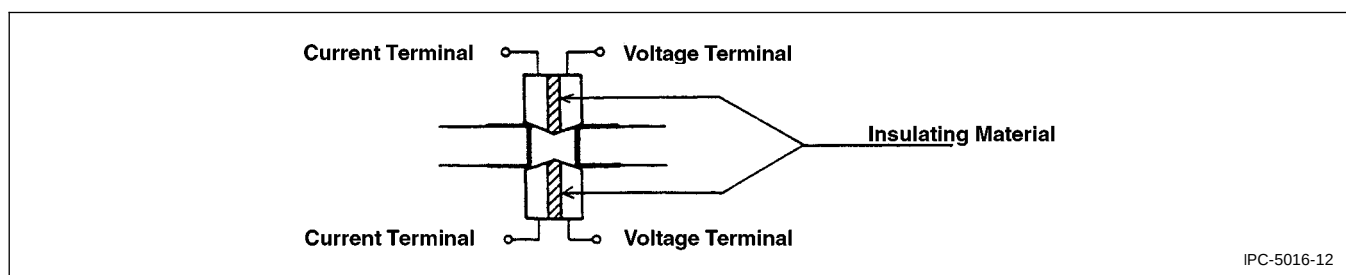


Figure 12 Method for Measurement of Plated-Through Hole Resistance

The specimen that causes mechanical damage, flashover, sparkover, or dielectric breakdown in this test shall not be used for other tests.

7.5.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.5.4 Test Apply the voltage specified in the detail specification as a DC voltage or a peak sinusoidal AC voltage at a frequency 50 Hz or 60 Hz to the specified part of the printed board. Raise the applied voltage gradually to the specified voltage in about five seconds, maintain the voltage for one minute, then examine for the existence or nonexistence of such abnormalities as mechanical damage, flashover, sparkover, and dielectric breakdown.

7.6 Insulation Resistance of Surface Layers

7.6.1 Equipment The equipment shall be the high insulation resistance meter specified in JIS C 1303 or a standard resistance, a universal shunt, and a galvanometer calibrated to an accuracy of $\pm 10\%$.

7.6.2 Specimen The specimen shall be the flexible printed board, test coupon, or test pattern of Figure 1, which has no coverlay or covercoat.

For double-sided flexible printed boards, two kinds of specimens (i.e., one in which the conductor pattern is formed on the front surface and the other having the pattern on the rear surface) shall be prepared.

7.6.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.6.4 Test Apply a DC voltage 500 ± 5 V, maintain the voltage for one minute, then measure the insulation resistance with the said voltage applied.

7.7 Electrical Integrity

7.7.1 Test for Circuit Isolation

7.7.1.1 Equipment The equipment shall consist of a voltage supply that can apply the test voltage, resistance measuring apparatus, and probes to have electrical connection with the specified positions on the conductor pattern.

The voltage supply shall allow current observation and shall have a function to limit the current within the current capacity of the test circuit to avoid the heating.

7.7.1.2 Specimen The specimen shall be the specified part of the flexible printed board.

7.7.1.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.7.1.4 Test Verify the absence of conductive connection between specified parts of a conductive pattern of a flexible printed board that were intended to be unconnected in accordance with the relevant specification (i.e., artwork, test data, detail specification, etc.).

Apply the test voltage specified in the detailed specification across the specified positions of the conductor pattern to be tested and obtain the resistance from the current passing through the conductors. If the measured resistance is not less than the minimum specified value, consider that isolation of the circuit is maintained.

The test voltage, duration of voltage application, and permissible minimum resistance value shall be as specified in the detailed specification.

7.7.2 Test for Circuit Continuity

7.7.2.1 Equipment The equipment shall consist of a current supply that can supply the test current, resistance measuring apparatus, and probes to have electrical connection with the specified positions on the conductor pattern.

7.7.2.2 Specimen The specimen shall be the specified part of the flexible printed board.

7.7.2.3 Preconditioning The preconditioning shall be as specified in Section 5.

7.7.2.4 Test Verify the establishment of electrical continuity through the specified joints of a conductive pattern, in accordance with the relevant specification (i.e., artwork, test data, detail specification, etc.).

Pass the test current specified in the detailed specification through the specified positions on the conductive pattern to be tested and obtain the resistance from the potential difference between the two points. If the measured resistance does not exceed the maximum specified value, consider that continuity of the circuit maintained.

The test current, duration of the current, and the permissible maximum resistance value shall be as specified in the detailed specification.

8 MECHANICAL PERFORMANCE TEST

8.1 Peel Strength of Conductor

8.1.1 Classification of Test Methods The test methods for peel strength of conductors are classified into the following two methods:

8.1.1.1 Method A In this method, the copper foil is peeled 90° to the surface from which the copper foil is removed. Unless otherwise specified, the test shall be carried out in accordance with this method.