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INTERNATIONAL STANDARD

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

IPC/JPCA-6202

February 1999

A joint standard developed by IPC and JPCA

2215 Sanders Road, Northbrook, IL 60062-6135
Tel. 847.509.9700 Fax 847.509.9798
www.ipc.org

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PERFORMANCE GUIDE MANUAL FOR SINGLE- AND DOUBLE-SIDED FLEXIBLE PRINTED WIRING BOARDS

FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public and established in an organization operating under given procedures.

IEC-PAS 62123 was submitted by the IPC (The Institute for Interconnecting and Packaging Electronic Circuits) and has been processed by IEC technical committee 52: Printed circuits.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
52/809/PAS	52/830/RVD

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- Minimize time to market
- Contain simple (simplified) language
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- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Keep people out
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- Tell you how to make something
- Contain anything that cannot be defended with data

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IPC/JPCA-6202

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

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.

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Flexible Circuits Acceptability Subcommittee (D-14) of the Flexible Circuits Committee (D-10) and the Flexible Circuits Committee of the Japan Printed Circuit Association (JPCA) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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IPC Flexible Circuits Acceptability Subcommittee

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Thomas Gardeski, DuPont High Performance Films

Duane Mahnke, Rogers Corp.

Michael Musich, Underwriters Laboratories, Inc.

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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 Assocation[1]

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 Commission[2]

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 IPC[3]

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-Chorne, 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 μm 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 ≤½W	l ≤2W
3	w1 ≤⅓W	l ≤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 ⅓ of the total circumference.

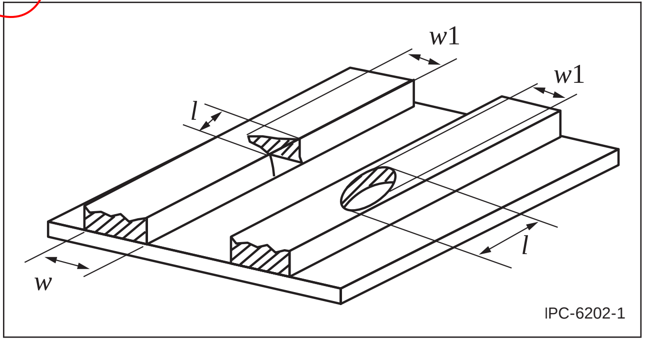

Figure 1 Nicks and Pinholes in Conductor

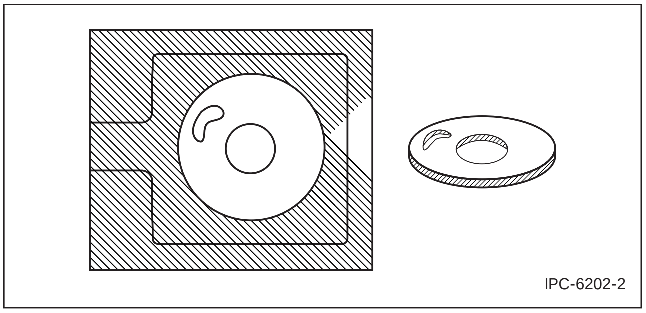

Figure 2 Reduced Area on Land

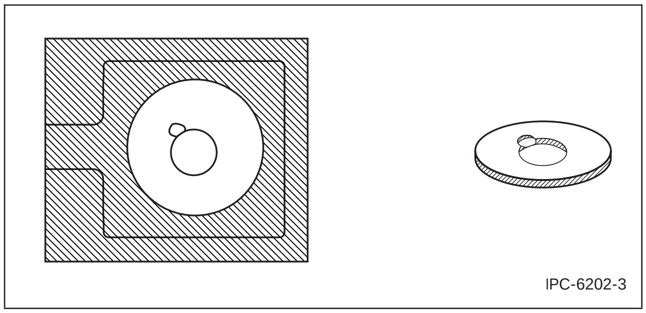

Figure 3 Circumferential Void at the Component Hole Corner

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) ≥½ b
3	a or (a1 + a2) ≥⅔ 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.

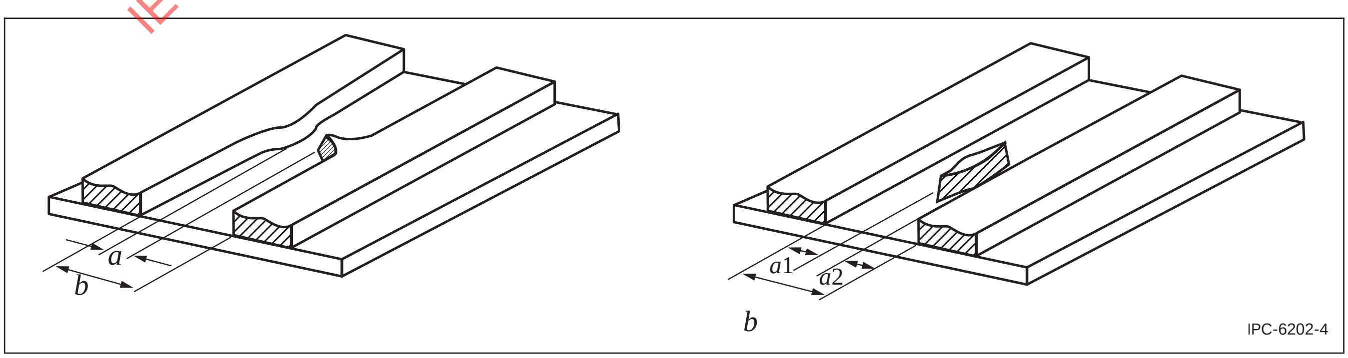

Figure 4 Extraneous Copper Between Conductors/Spurs and Nodules of Conductors Corner

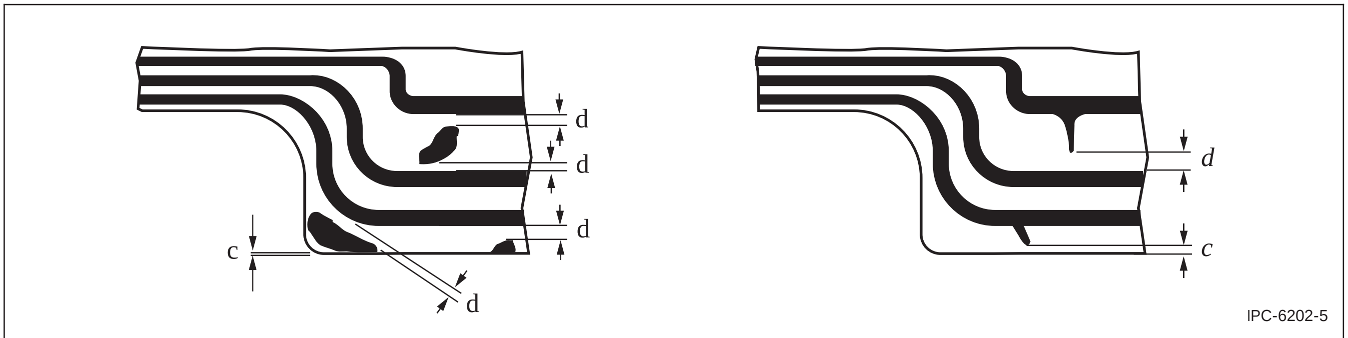

Figure 5 Extraneous Copper and Spurs and Nodules in Open Area and Nodules of Conductors Corner

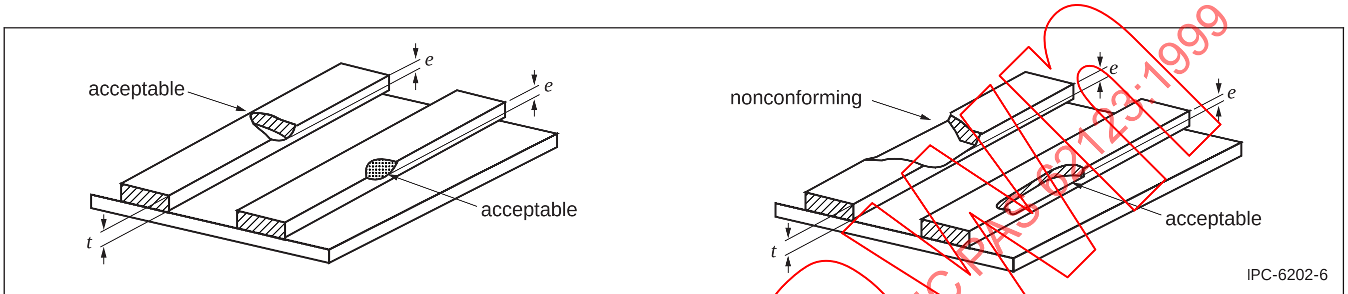

Figure 6 Etched Concave on Conductor Surface and Nodules of Conductors Corner

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

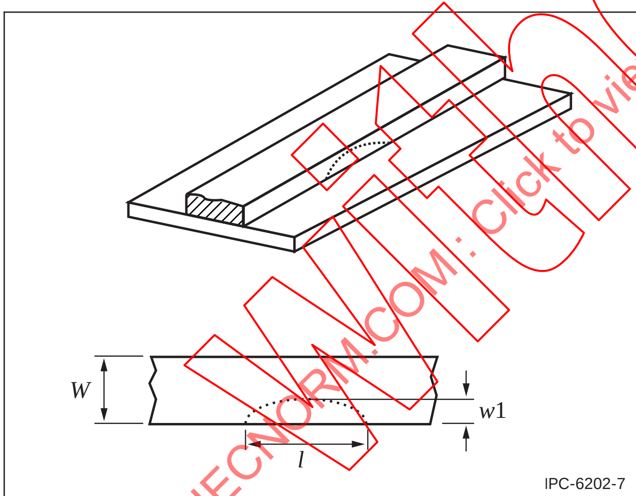

Figure 7 Conductor Delamination

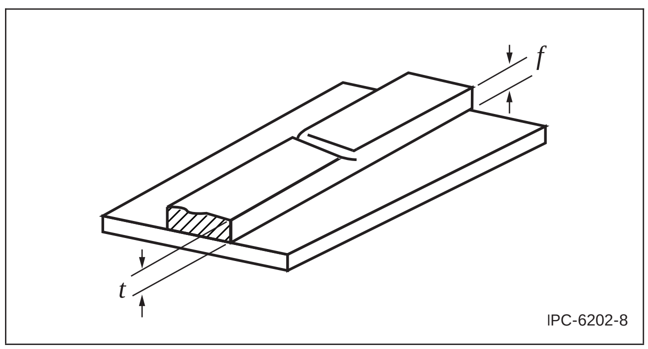

Figure 8 Scratches on Conductor

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.

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.

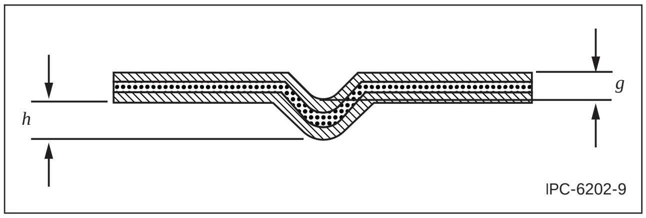

Figure 9 Dents

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 (q) 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 ≤⅓ t
3	i ≤⅕ 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 Coverlayer and Covercoat

Level	Scratches
1	There **shall** be no exposure of conductor.
2	Depth (i) ≤⅓ of thickness of coverlay or covercoat (t)
3	Depth (i) ≤⅕ 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.

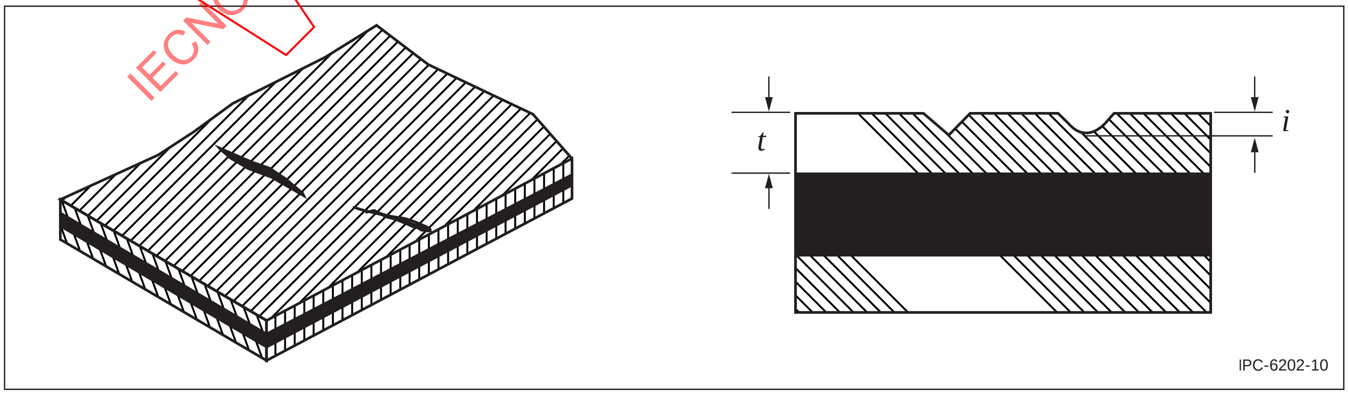

Figure 10 Scratch on Base Film

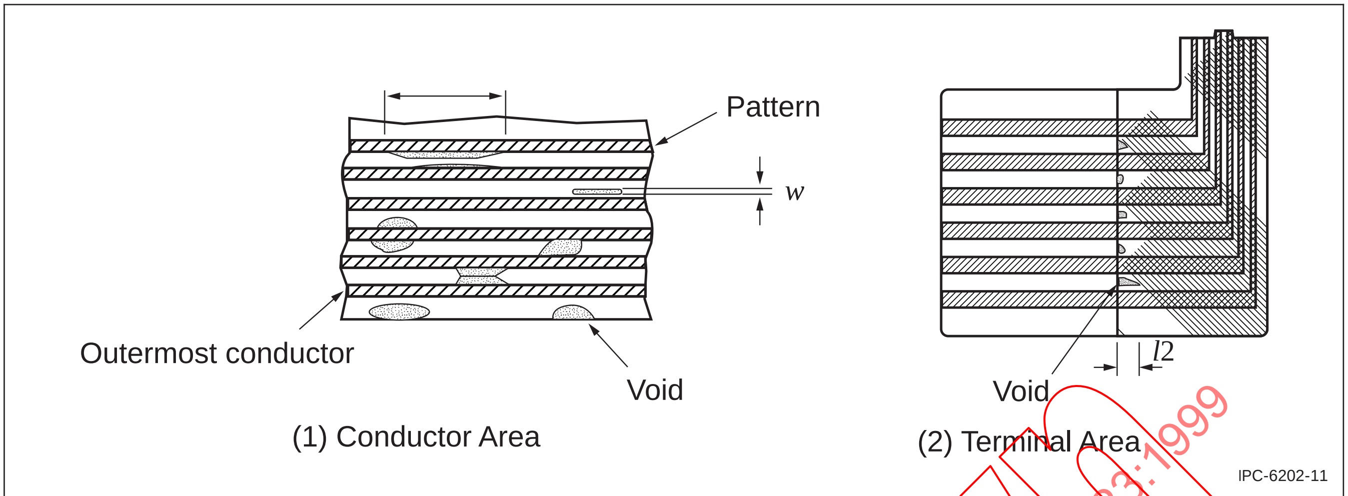

Figure 11 Allowable Voids

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 ≤½ 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 ≤⅓ 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 17.

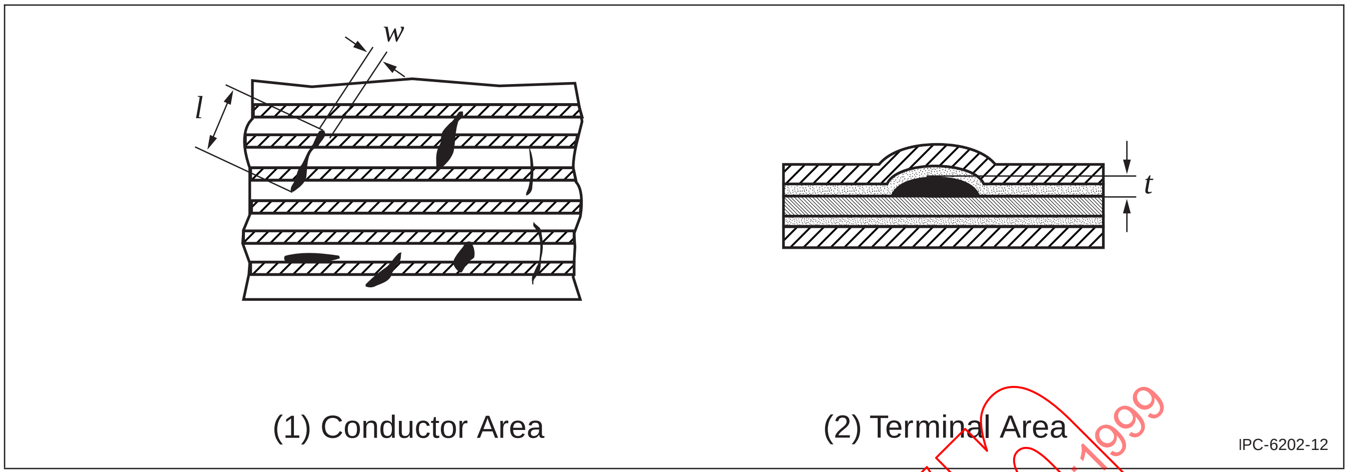

Figure 12 Foreign Matters

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

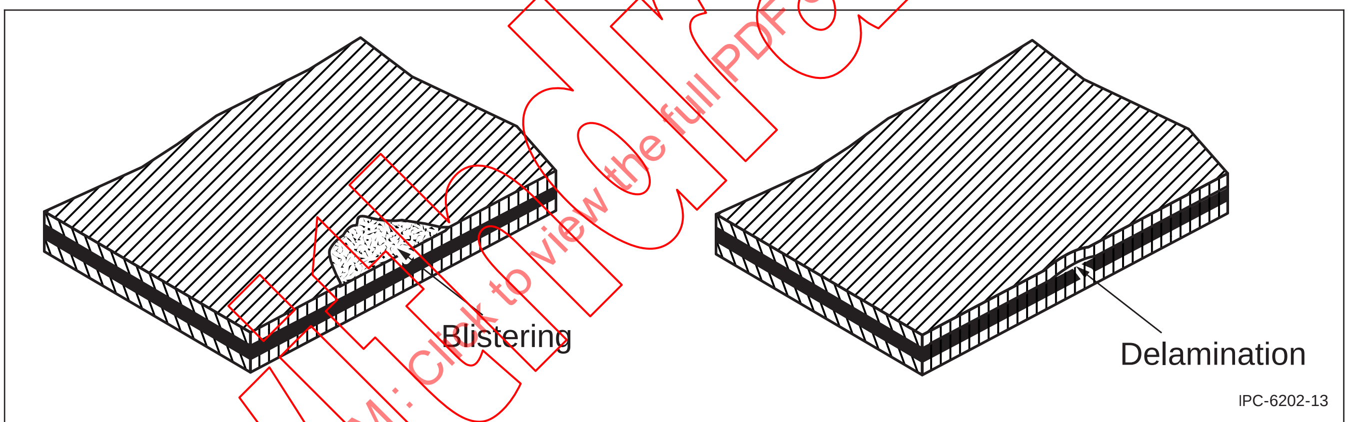

Figure 13 Lifting and Delamination of Coverlay and Covercoat

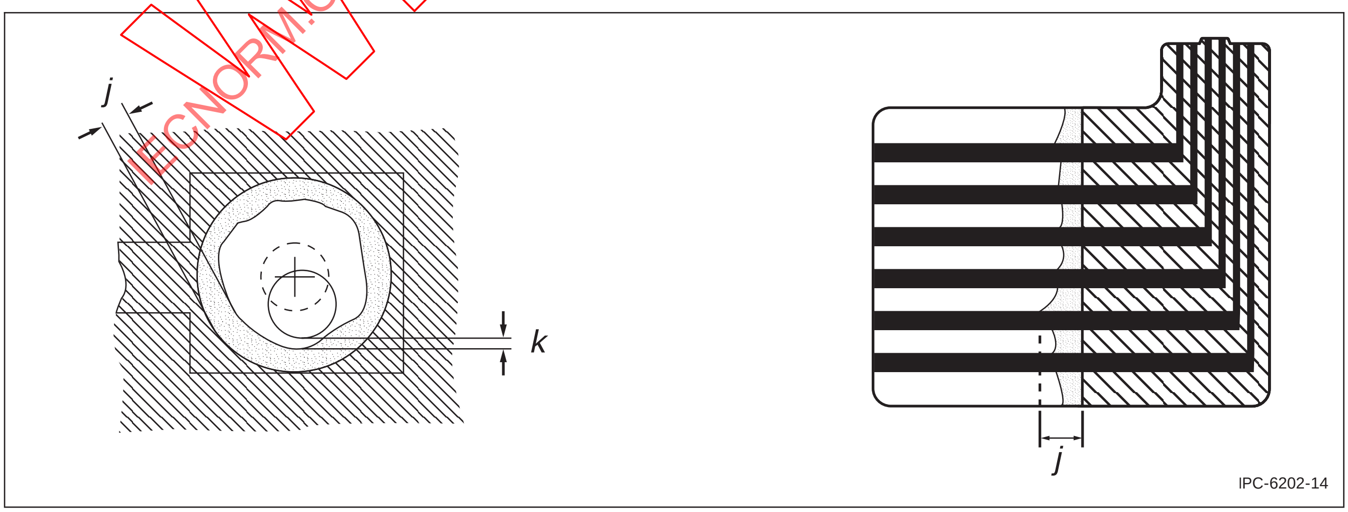

Figure 14 Allowable Squeeze-Out of Coverlay Adhesive and Ooze-Out of Covercoat

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 ⅓ 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 ≤½ 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 ⅓ 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 bv 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 (h) 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 ≤5% of the bonding area of the printed board and stiffener.

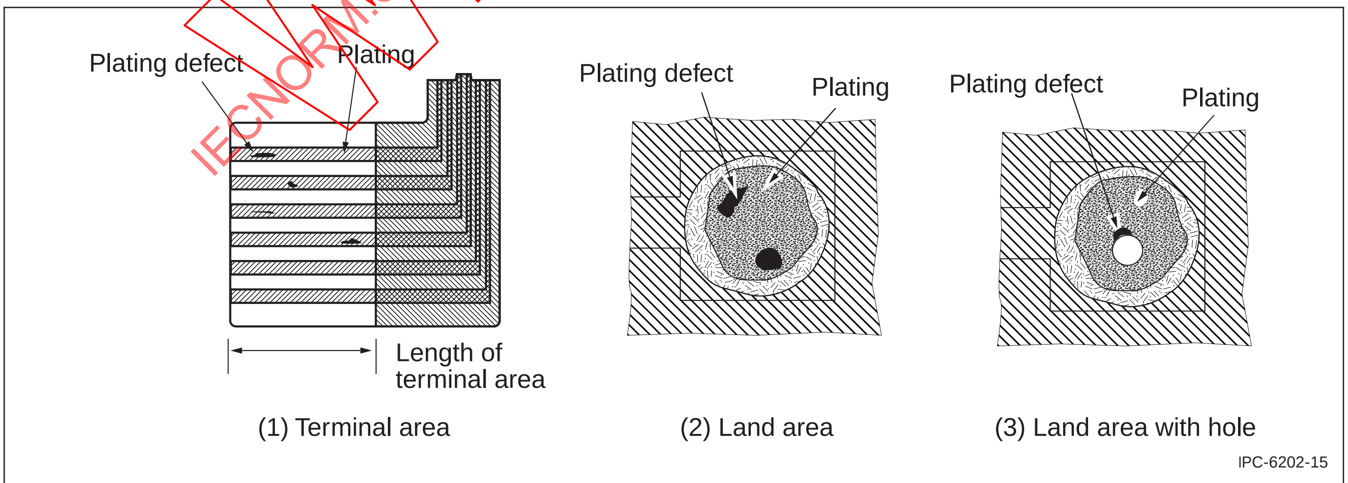

Figure 15 Plating Defects

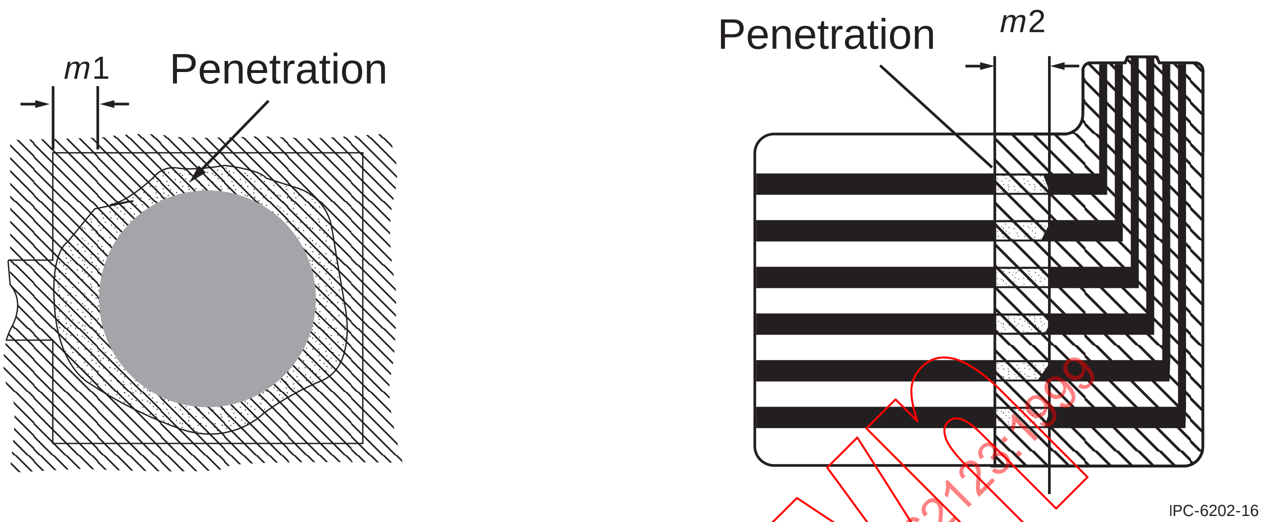

Figure 16 Penetration of Plated Metal or Solder

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 dirts 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 dirts 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 ≤10% of the area of the stiffener. On the other hand, when other types of adhesive are used, the area of voids **shall** be ≤⅓ 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).

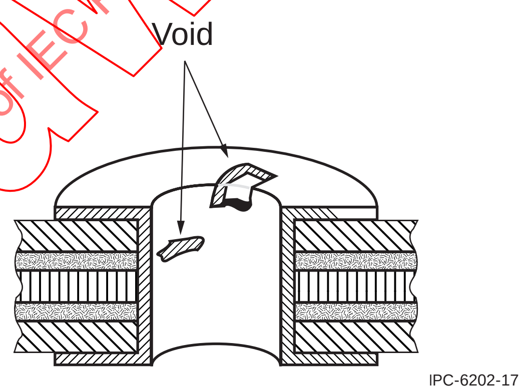

Figure 17 Plating Voids in Plated-Through Hole

Table 20 Allowable Plating Voids

Level	Total Void Area
1 and 2	<⅓
3	<10%

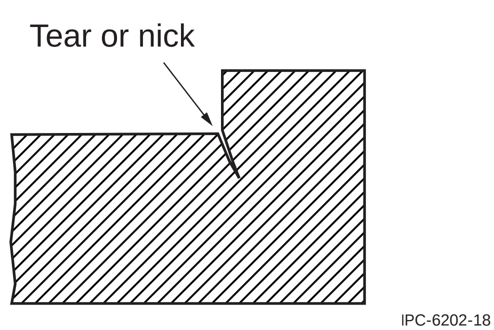

Figure 18 Tears and Nicks

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.

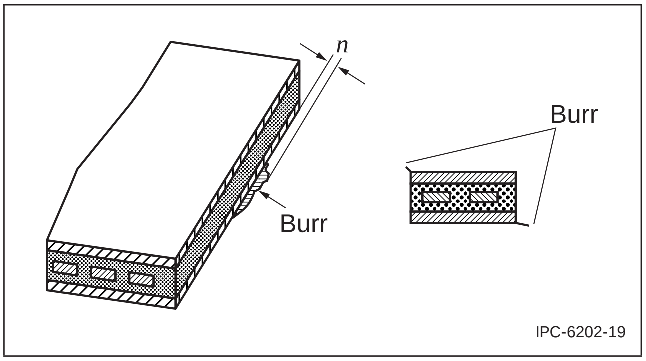

Figure 19 Burrs

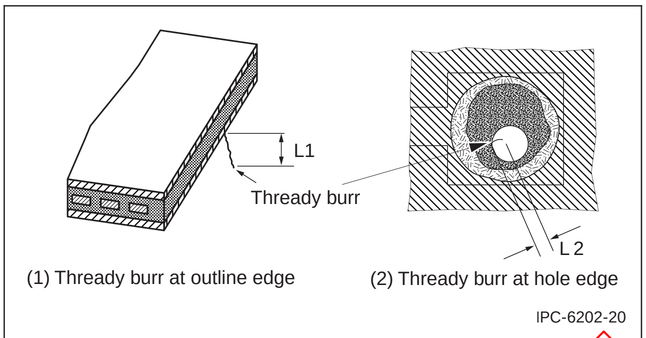

Figure 20 Thready Burrs

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.

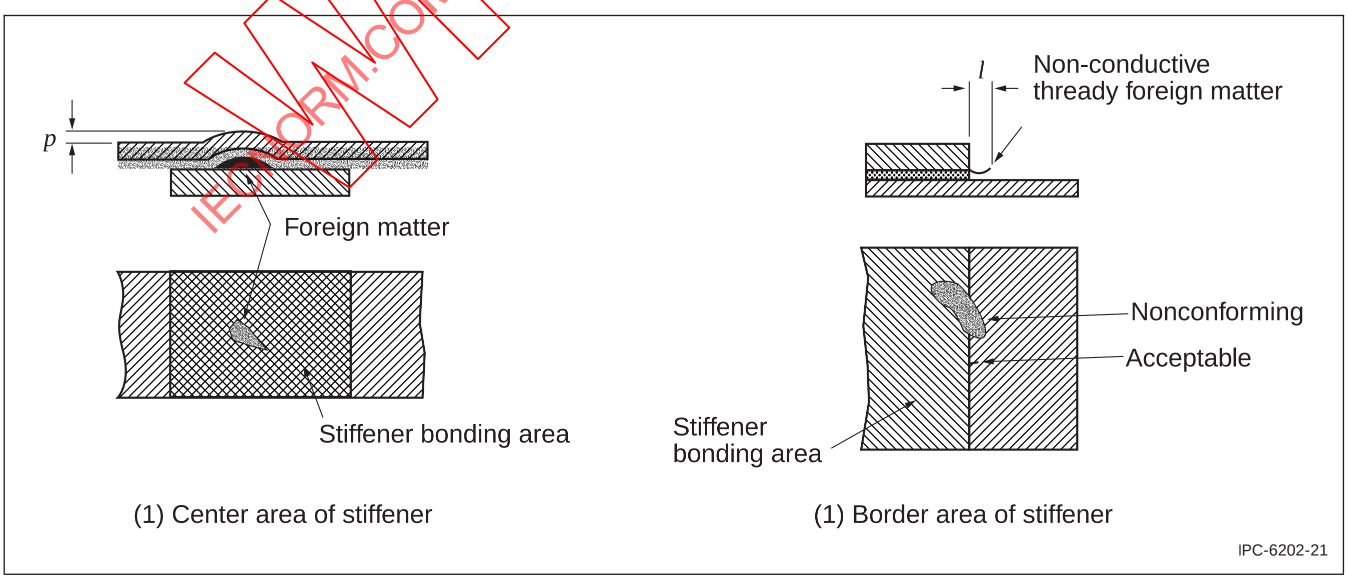

Figure 21 Foreign Matter Between Board and Stiffener

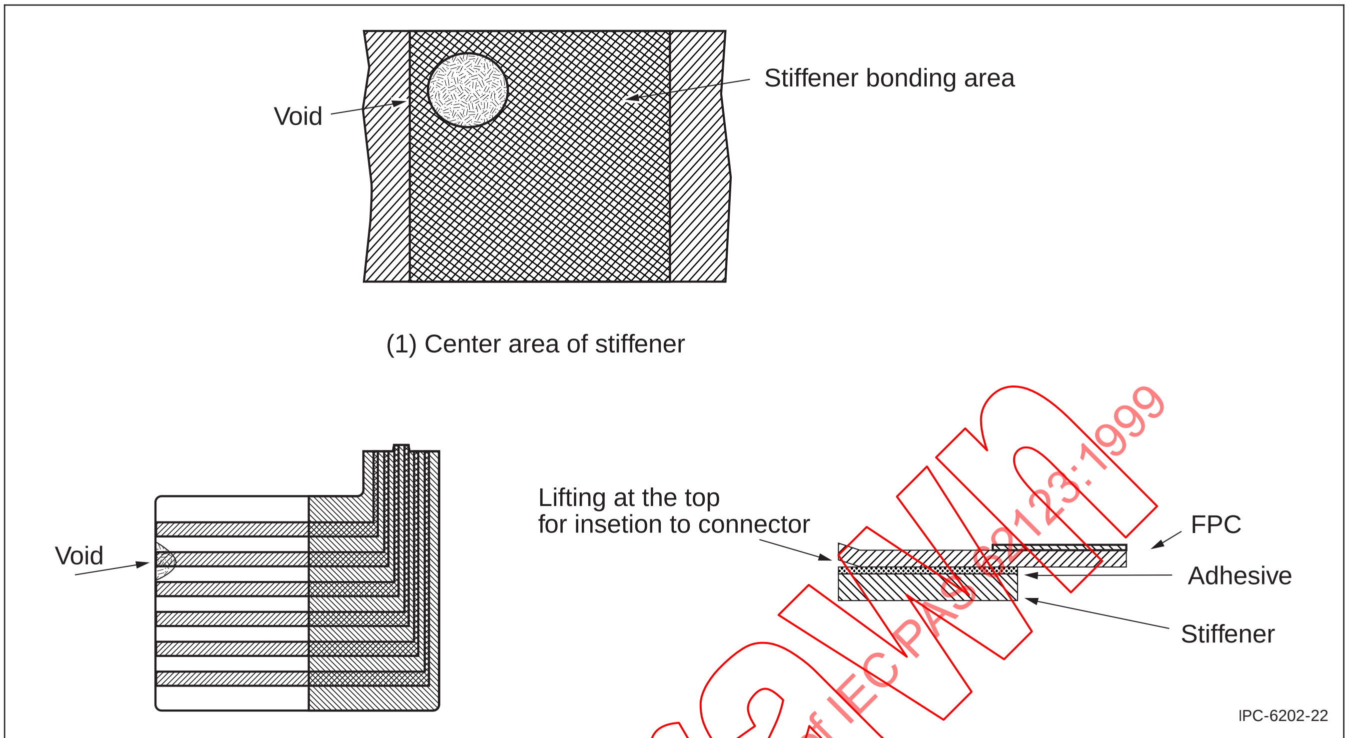

Figure 22 Voids Between Board and Stiffener

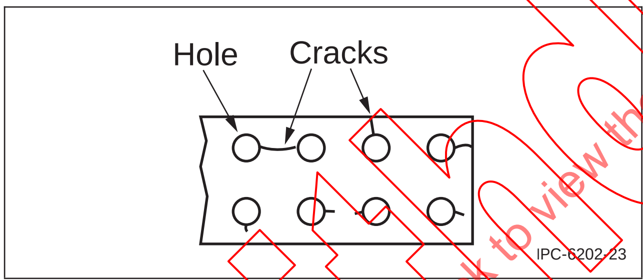

Figure 23 Cracks

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 of 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 ≤ ± 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 ≤ ± 0.3%, excluding via holes.

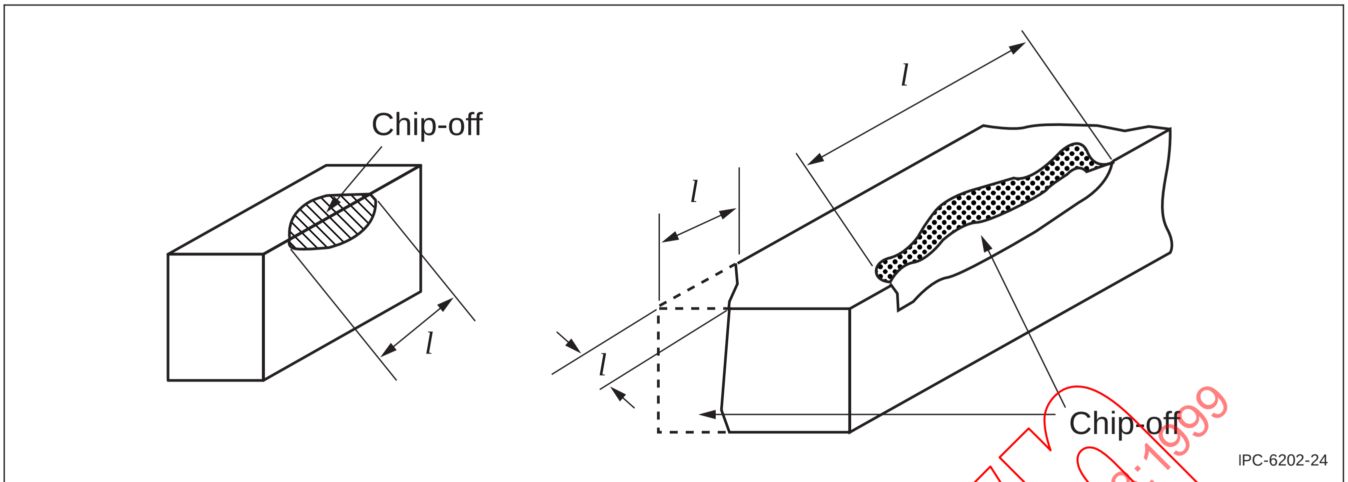

Figure 24 Chip-Off

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.

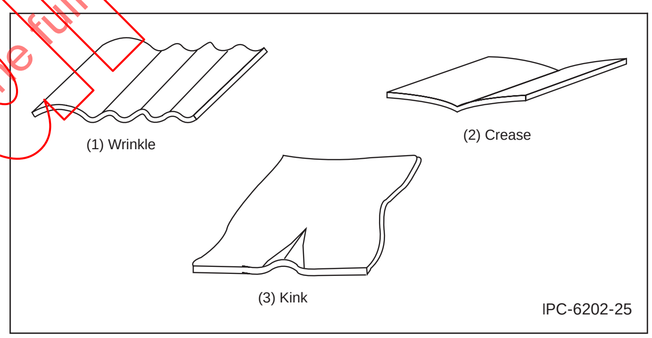

Figure 25 Protrusions and Dents on Flexible Printed Board

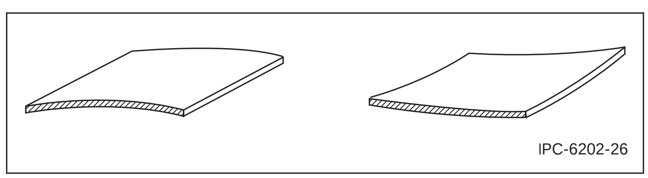

Figure 26 Bow and Twist

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 ≤ ± 0.3 mm for an external dimension <100 mm, and **shall** be ≤ ± 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: ± 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 ≤ ± 0.08 mm.
2	Minimum hole diameter after plating **shall** be 0.4 mm, and the tolerance **shall** be ≤ ± 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	≤ ± 0.050
≥0.10 and <0.30	≤ ± 0.08
≥0.30 and <0.50	≤ ± 0.10
≥0.50	≤ ± 20%

Table 30 Conductor Clearances and Tolerances (mm)

Designed Conductor Clearance	Tolerance
≤0.10	≤ ± 0.05
≥0.10 or ≤0.30	≤ ± 0.08
≥0.30	≤ ± 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 ≤ ± 0.30, and for distances of ≥100 mm, **shall** be ≤ ± 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 diameter 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).

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.

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 ≤ ± 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.

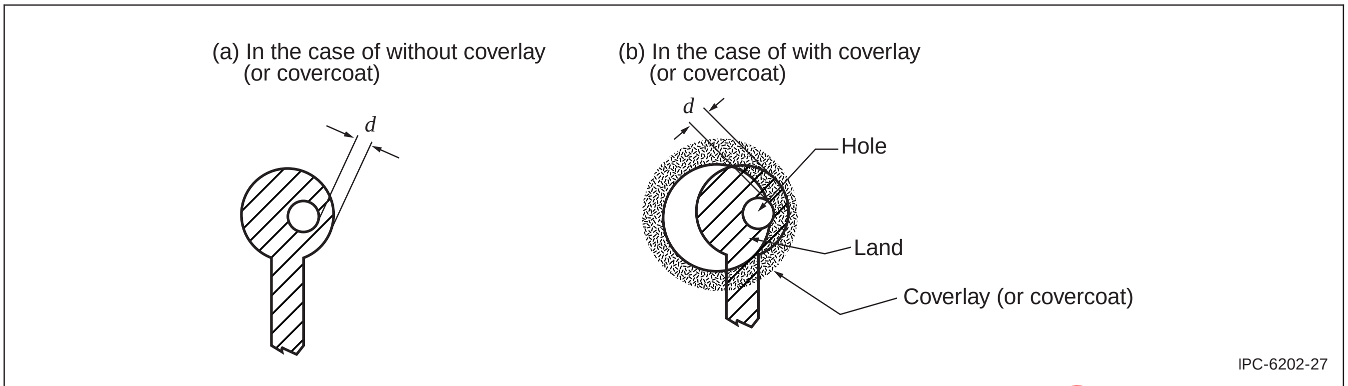

Figure 27 Misregistration of Hole and Land

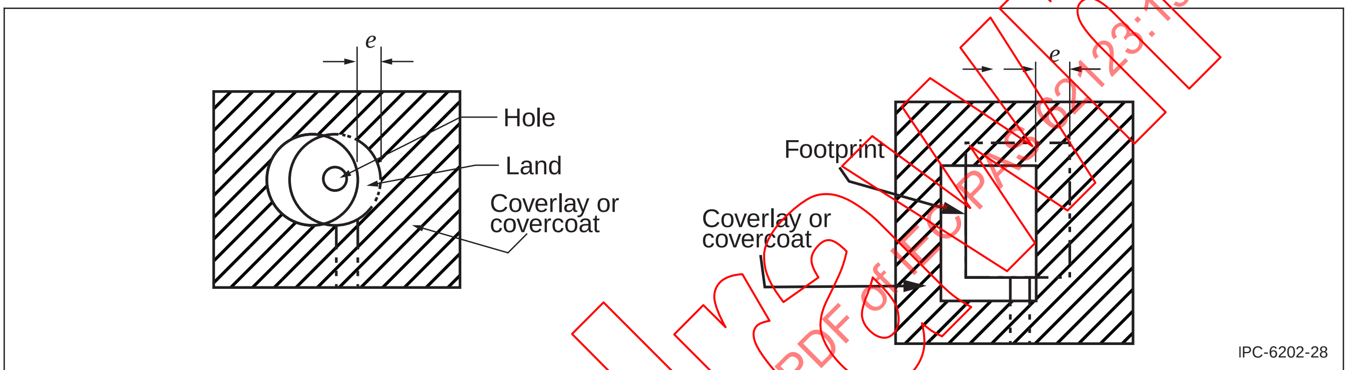

Figure 28 Misregistration of Land and Coverlay (or Covercoat)

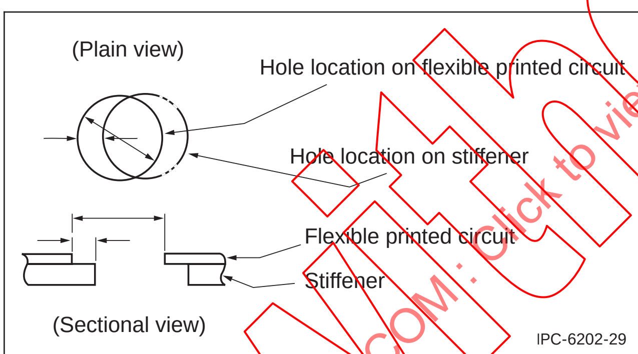

Figure 29 Registration of Holes

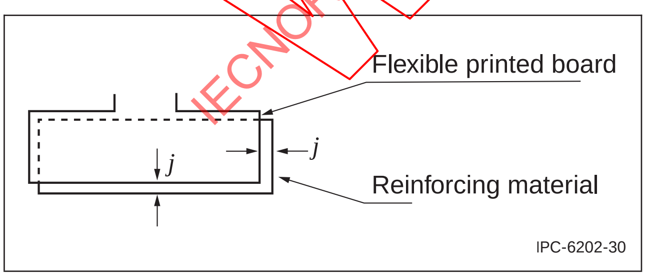

Figure 30 Registration of Outlines

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	≤ ± 0.5 mm
2	≤ ± 0.3 mm
3	≤ ± 0.2 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 ≥0.1 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.

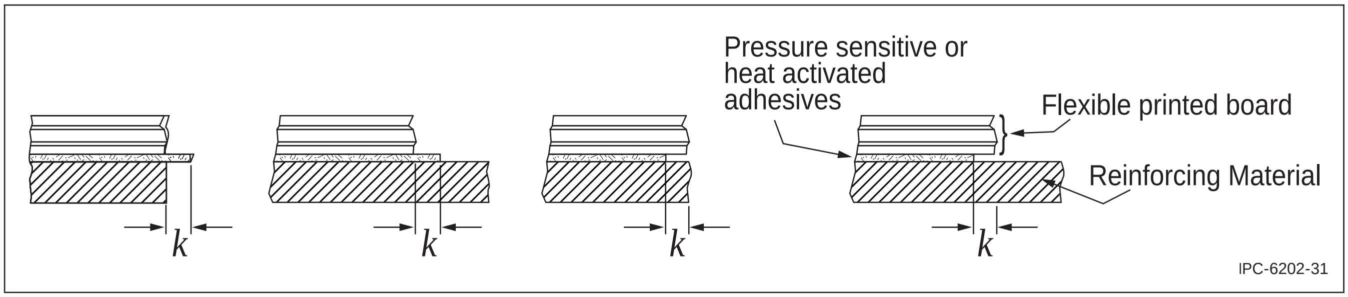

Figure 31 Registration of Pressure Sensitive or Heat Activated Adhesives from Flexible Printed Board and Stiffener (Including Adhesive Squeeze-Out)

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	≥5 x 10^8 Ω	Per paragraph 7.6 (Insulation resistance, surface layers)
		After humidity test	Level 1: **shall** retain the electrical functions Level 2: ≥1 x 10^8 Ω Level 3: ≥5 x 10^8 Ω	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 unpractical.

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 most 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.

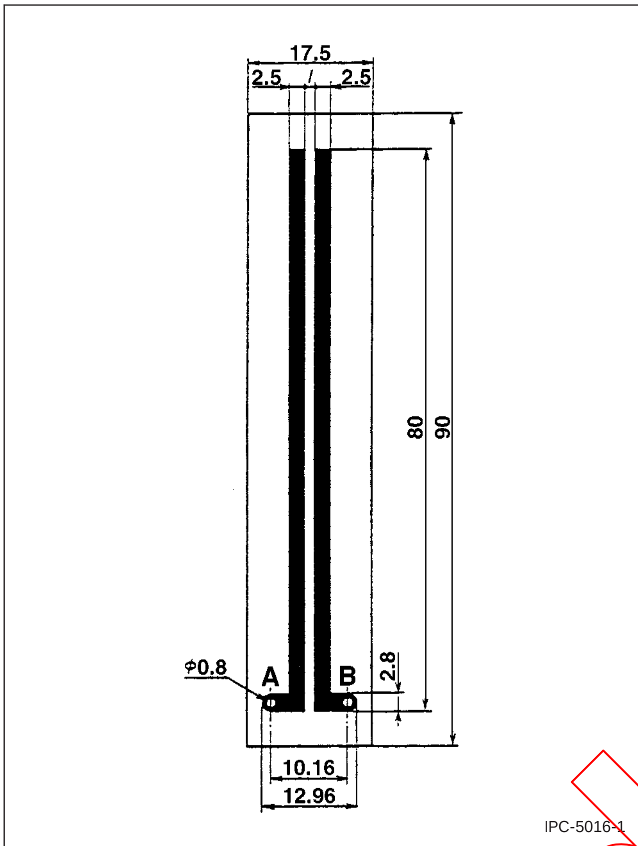

Figure 1 Specimen for Voltage Proof and Insulation Resistance

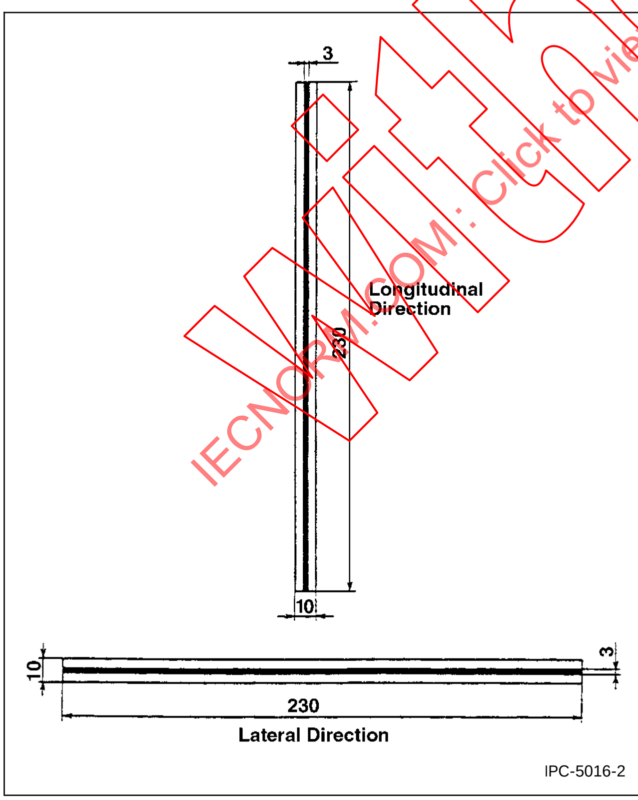

Figure 2 Specimen for Peel Strength

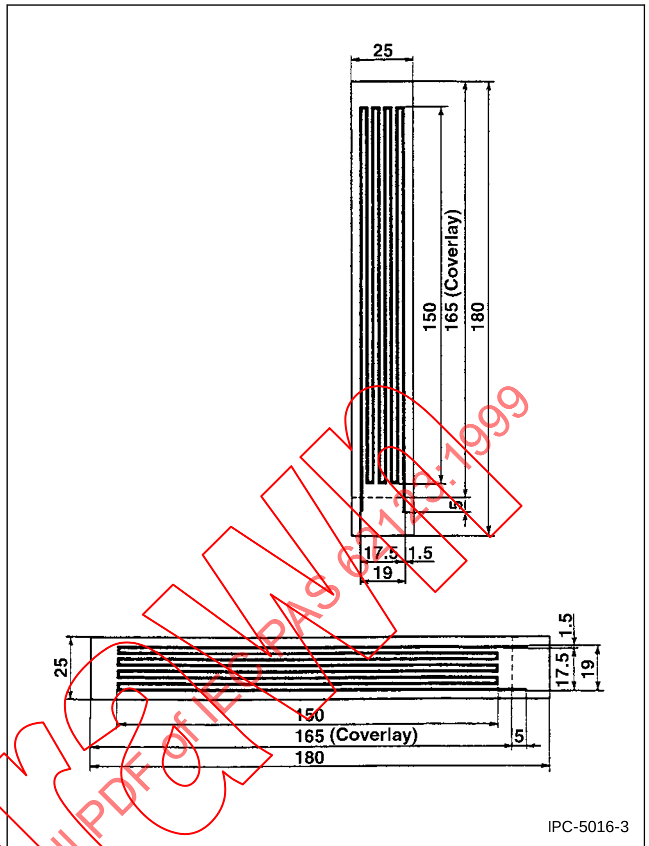

Figure 3 Sample for Resistance to Flexure

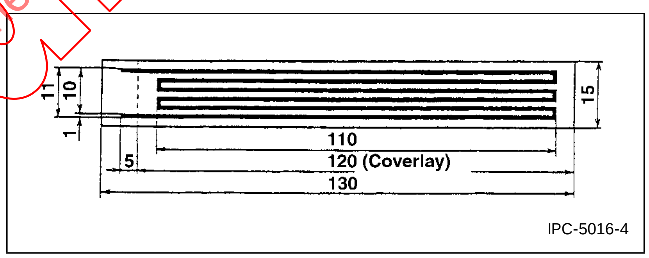

Figure 4 Specimen for Resistance to Fold

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.

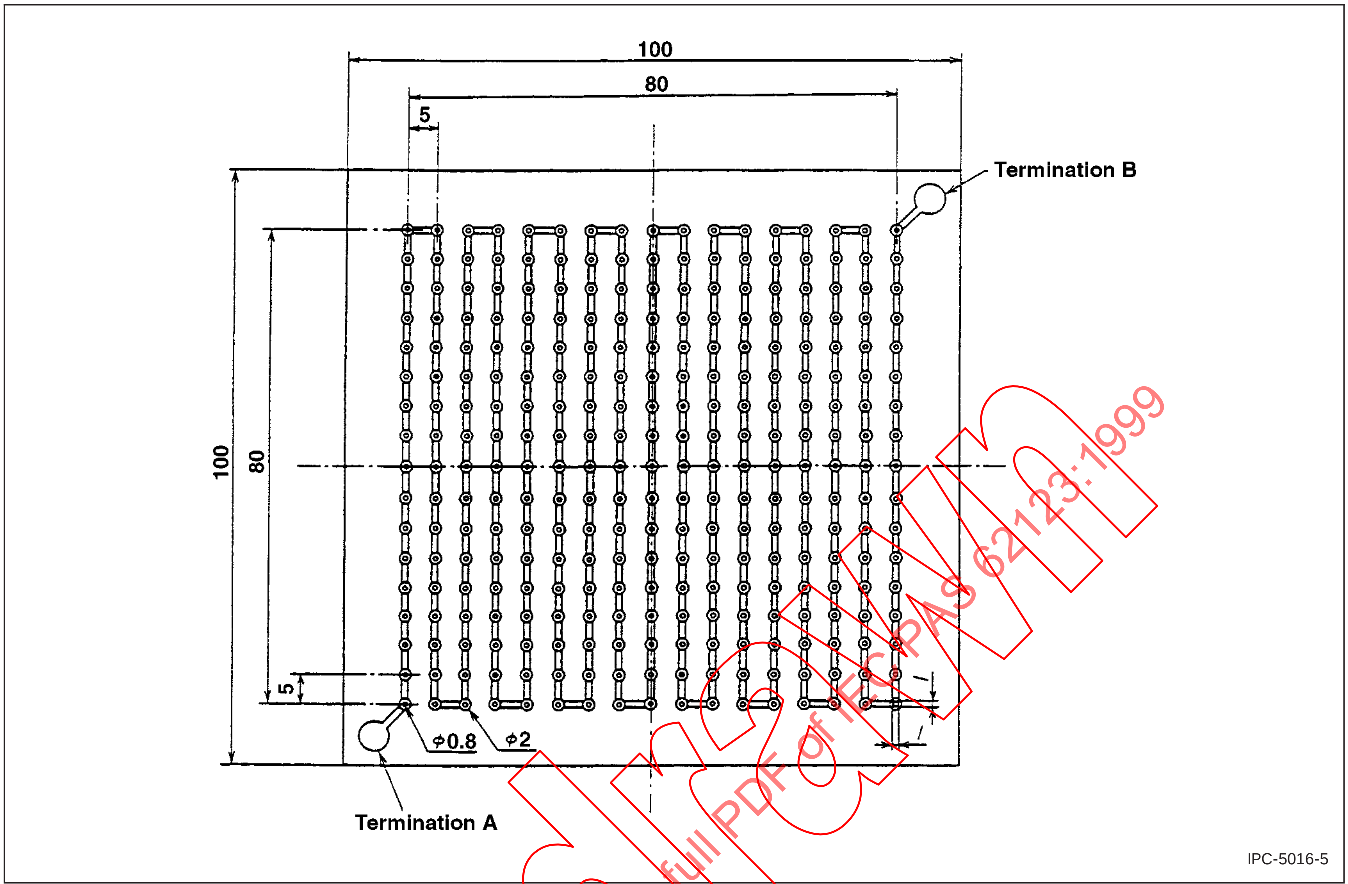

Figure 5 Specimen for Electrical Resistance and Current Proof of Plated-Through Hole and for Resistance to Thermal Shock of Copper Plated-Through Hole

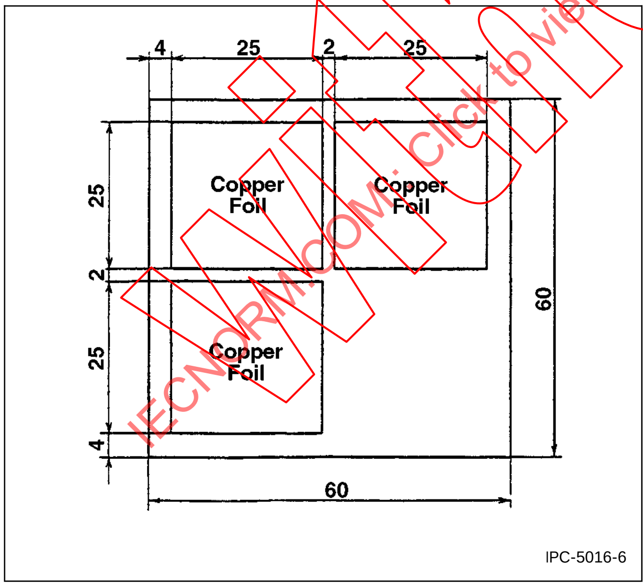

Figure 6 Specimen for Resistance to Solder Heat and Resistance to Chemical (for base material, cover lay and cover coat)

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.

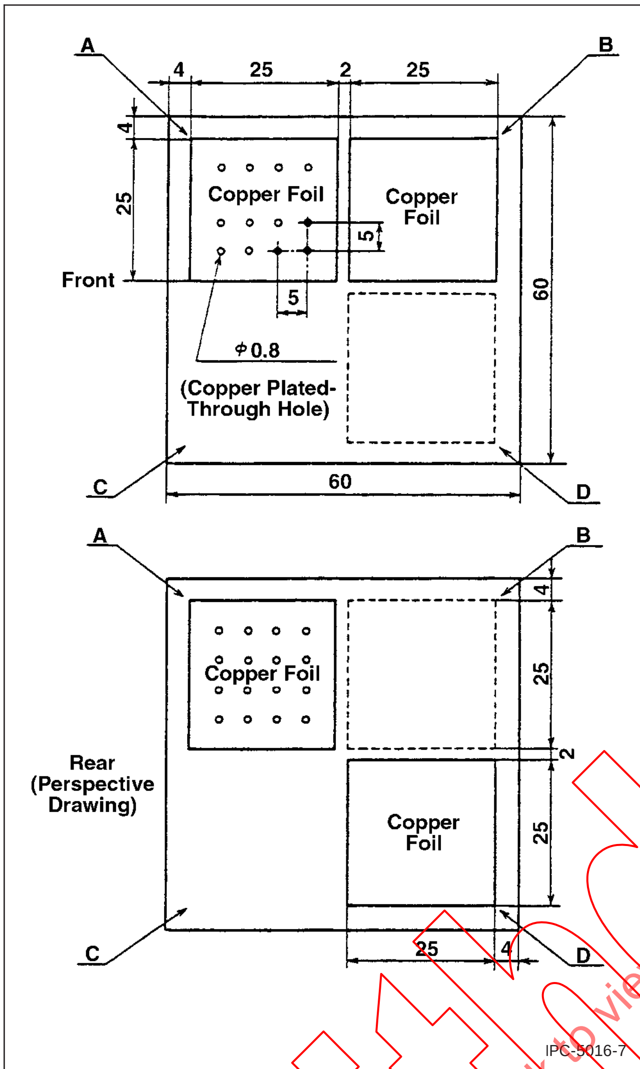

Figure 7 Specimen for Resistance to Soldering Heat and Resistance to Chemical (for base material, coverlay and covercoat)

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.

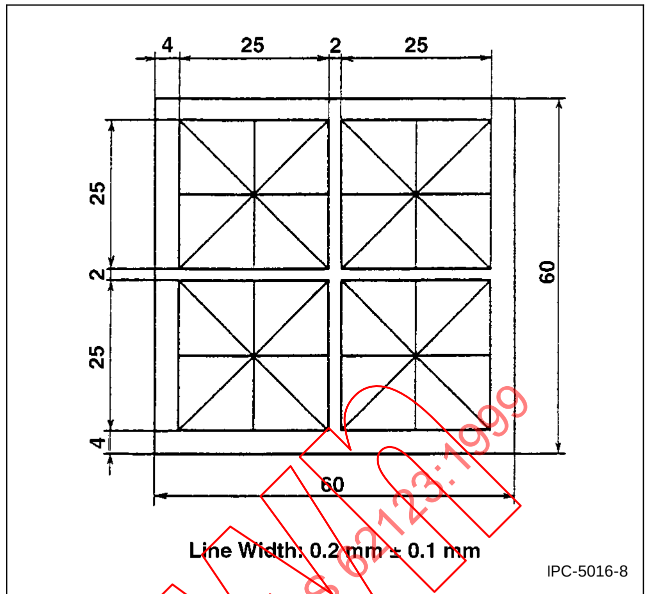

Figure 8 Specimen for Resistance to Soldering Heat and Resistance to Chemical (for symbol marking)

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.

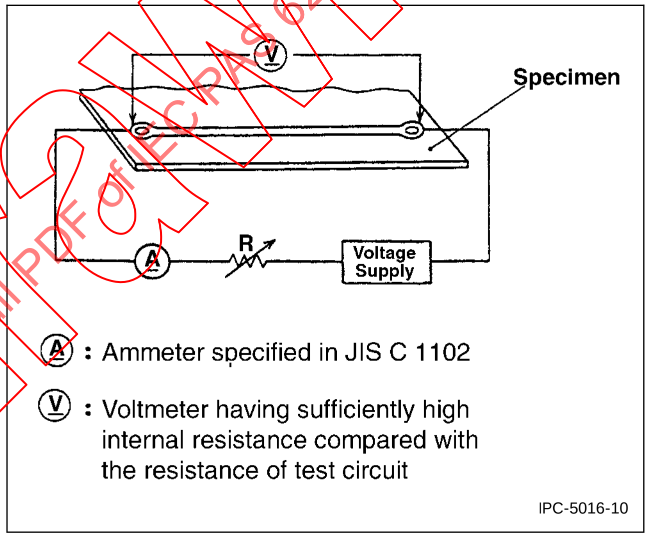

Figure 10 Measuring Equipment of Conductor Resistance

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.

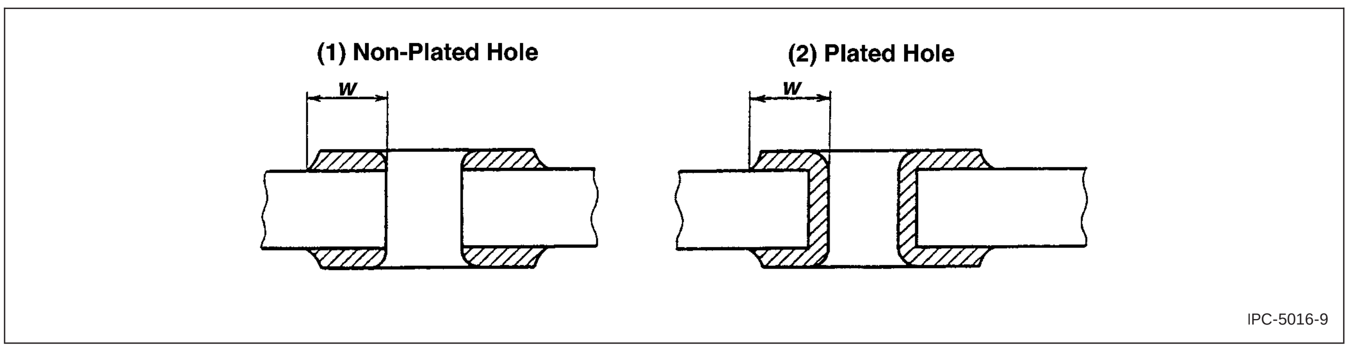

Figure 9 Land Width

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 ± 5% by means of the method shown in Figure 11.

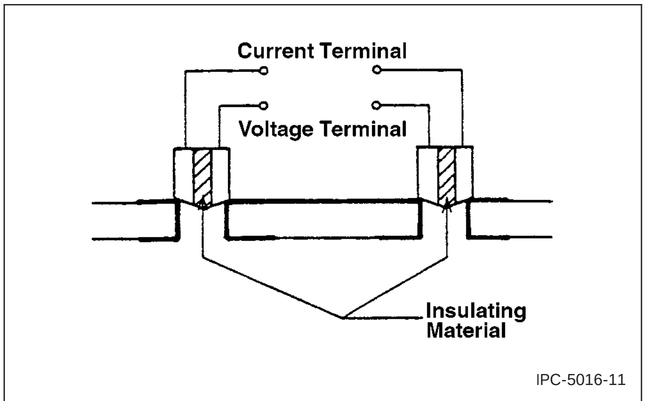

Figure 11 Measuring Method of Conductor Resistance

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 ± 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 nonexistence 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.

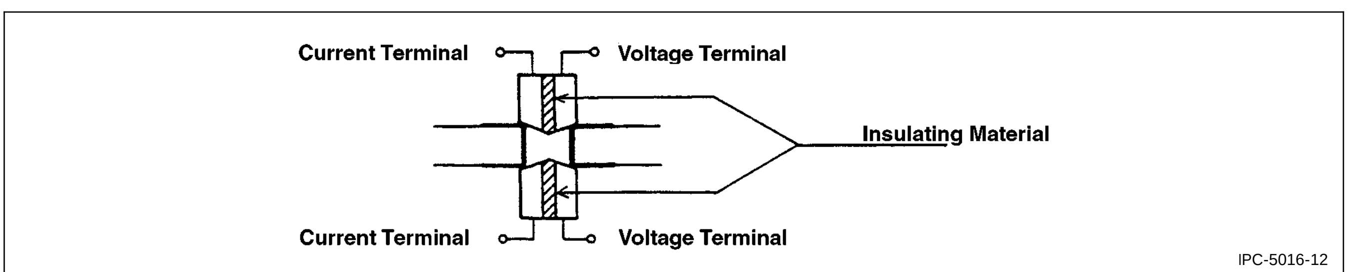

Figure 12 Method for Measurement of Plated-Through Hole Resistance

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 ± 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.

8.1.1.2 Method B In this method, the copper foil is peeled 180° to the surface from which the copper foil is removed. This method may be used subject to agreement between the parties concerned with acceptance in such cases that the base material is thin (i.e., the thickness is less than 0.025 mm and it is difficult to fix the specimen to the support so that it will not cause tenting or break due to the peeling load) or that it is desired to obtain the approximate measured values quickly.

8.1.2 Equipment

8.1.2.1 Tensile tester with a ± l% error probability of the indication (the peeling load falls 15% to 85% of the capacity of the tester, and the cross head speed can be maintained approximately 50 mm/minute) and a recorder that can continuously record the peeling force

8.1.2.2 A support exemplified in Figure 13 and Figure 14 to keep the angle of copper foil peeling direction to the specimen surface from which the copper foil is removed 90° ± 5°, for application of method A, or a support having the equivalent function

8.1.2.3 Vernier caliper with minimum reading 0.05 mm, as specified in JIS B 7507, or equivalent

8.1.2.4 Solder bath containing the molten solder specified in 10.4.4 to a depth ≥50 mm, which is capable of controlling the temperature of solder at a specified position within the tolerance of ± 3°C over 200°C to 300°C

8.1.3 Specimen When the test pattern of Figure 2, manufactured by means of etching, using a copper-clad laminate for flexible printed board, serves as the specimen, two specimens from each longitudinal direction (rolling direction) and lateral direction (direction perpendicular to rolling direction) (i.e., four specimens in total) shall be prepared. For double-sided flexible printed boards, two specimens from each direction and each side (i.e., eight specimens in total) shall be prepared.

If there is a straight conductor of adequate length and uniform width in the flexible printed board, it may be used as the specimen subject to agreement between the parties concerned with acceptance.

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

8.1.5 Tests Carry out the tests as stated in 8.1.5.1 through 8.1.5.4.

8.1.5.1 Normal State Precondition the specimen in accordance with Section 5 of this Standard, then carry out the test in accordance with 8.1.6.

8.1.5.2 After Heating Hold the specimen vertically for one hour in the thermostatic chamber of an air circulating system at 130°C ± 5°C of PET (polyester film). Hold at 180°C ± 5°C for PIA (pyromellitic acid polyimide film) and PIB (biphenyl tetracarbonic acid polyimide film). Allow the specimen to stand under the standard conditions of 3.1 for 24 hours ± 4 hours, then test it as specified in 8.1.6.

8.1.5.3 After Immersion in Solder Maintain the specimen in a thermostatic chamber of an air circulating system at 105°C ± 5°C for one hour or more and quickly float it on the molten solder specified in 10.4.4 for 5 seconds +1, -0 seconds. Allow it to stand under the standard conditions of 3.1 for 24 hours ± 4 hours, then test it as specified in 8.1.6. Paste a masking tape on the copper foil surface, immerse the specimen in silicone oil resistant to heat up to

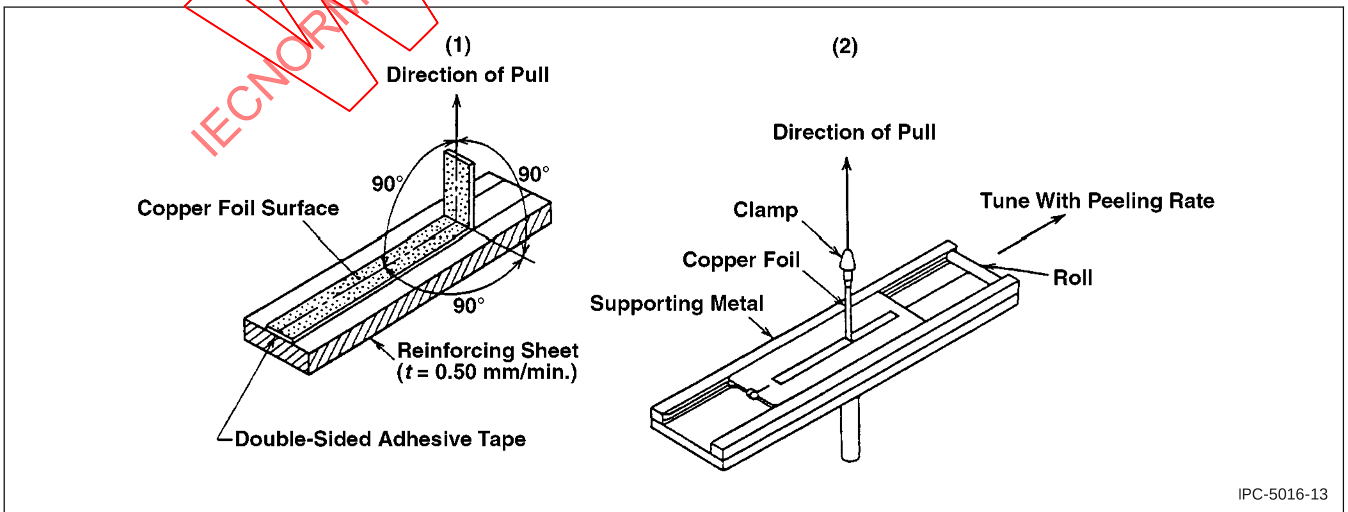

Figure 13 Sliding Support for Measurement of Peel Strength by Method A (Peeling at 90°)

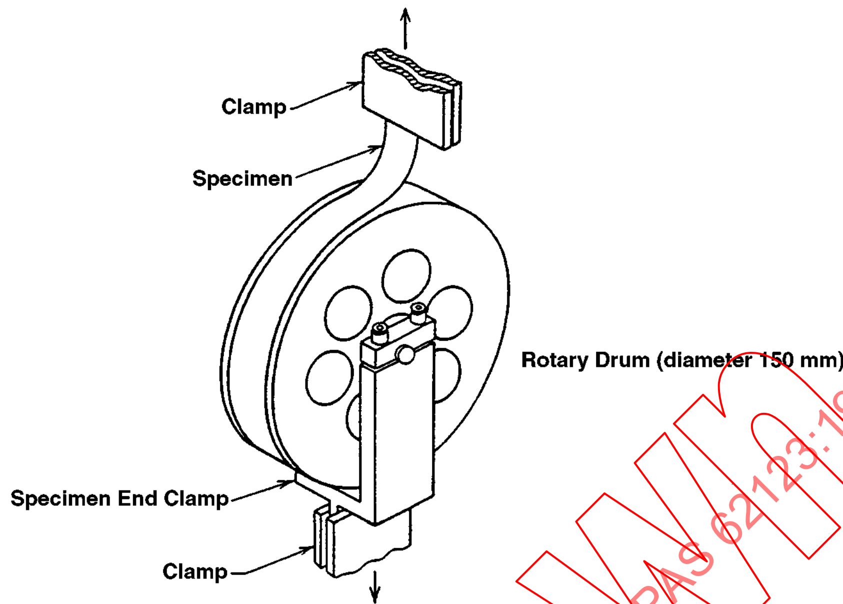

Figure 14 Rotary Drum Type Support for Measurement of Peel Strength by Method A (peeling in a direction 90°)

260°C, or carry out similar treatment to avoid adhesion of solder on the copper foil surface at immersion into solder.

Note: This step is not applicable to flexible printed board employing polyester film as base material.

8.1.5.4 After Immersion in Chemicals Maintain the specimen in a chemical at 23°C ± 5°C for five minutes, take out the specimen, completely wipe off the chemical, allow it to stand under the standard conditions of 3.1 24 ± four hours, and then test it as specified in 8.1.6. However, in the case of inorganic chemicals, take out the specimen from the chemical, wash it completely with water, dry it at 80°C ± 5°C for 30 minutes, allow it to stand under the standard conditions of 3.1 for 24 ± four hours, then carry out this test.

As for the chemicals, use hydrochloric acid (2 mol/1) as the acid, aqueous solution of sodium hydroxide (2 mol/1) as the alkali and the 2- propanol specified in JIS K 8839 as the alcohol, and carry out the test as specified in 8.1.6 on all the chemicals.

8.1.6 Measurement The measuring method shall be as stated in 8.1.6.1 and 8.1.6.2.

8.1.6.1 Method A (Method of Peeling in at 90°)

(a) Measure the conductor width of the specimen, then fix the specimen to the tensile tester. At this fixing, to ensure peeling at 90°, paste the reinforcing sheet with double-sided adhesive tape as illustrated in Figure 13 (1) so slip or uneven force will not appear. Use the supporting metal as illustrated in Figure 13, which can slide perpendicular to the direction of the pull being tuned with the peel strength; or use the drum as illustrated in Figure 14, which can freely rotate and firmly attach the specimen with double-sided adhesive tape. Continuously peel the copper foil perpendicular to the surface of the specimen by 50 mm or more by employing either of the above procedures and measure the load during such procedures.

(b) Use an adequate digital recording device, let it read the value of the load at three or more points per one second, record the average value of every second, then take the minimum value among the average values so obtained as the peel load (N). Discard the values of the load during the first five seconds to eliminate the overshoot part at initiation of peeling.

(c) Using an adequate analog recording device, let it draw the load continuously as exemplified in Figure 15, Figure 16, and Figure 17, place a straight edge on the part, excluding the overshoot portion where the load is stable on the chart (stable parts of Figure 15 and Figure 16), and determine the average value of the load (the average value may be taken as the peeling load).

In this procedure, if the mode of peeling changes in the procedure as exemplified in Figure 15, take the minimum value among the average values of the load estimated at each stabilized area as the peeling load (N).

If there is no stabilized area in the peeling mode as exemplified in Figure 16, take the minimum load as the peeling load (N).

(d) Obtain the values of the peeling load (N) divided by the peeling conductor width (mm) on each specimen

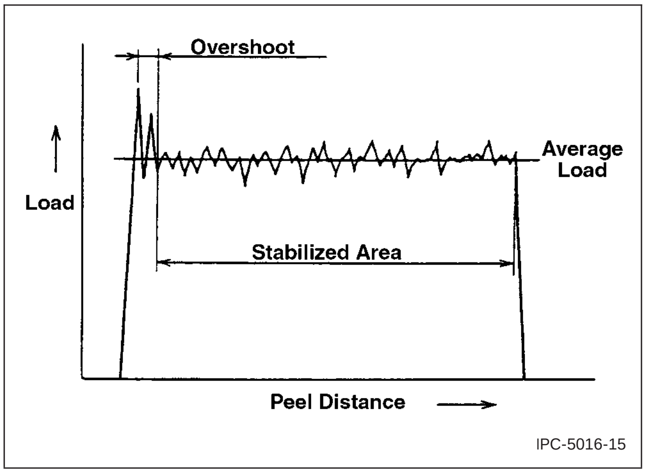

Figure 15 Uniform Peeling Mode

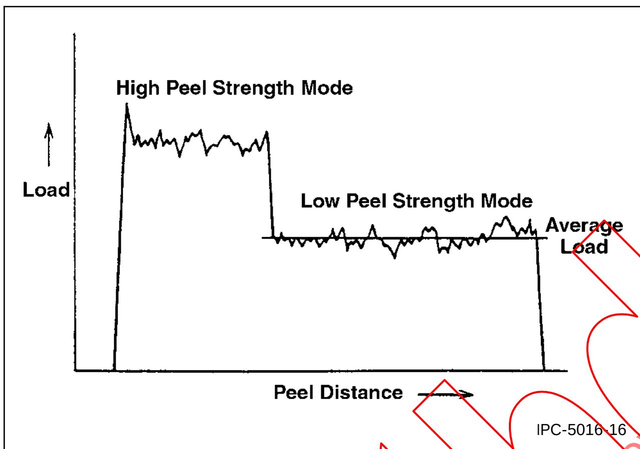

Figure 16 Non-Uniform Peeling Mode

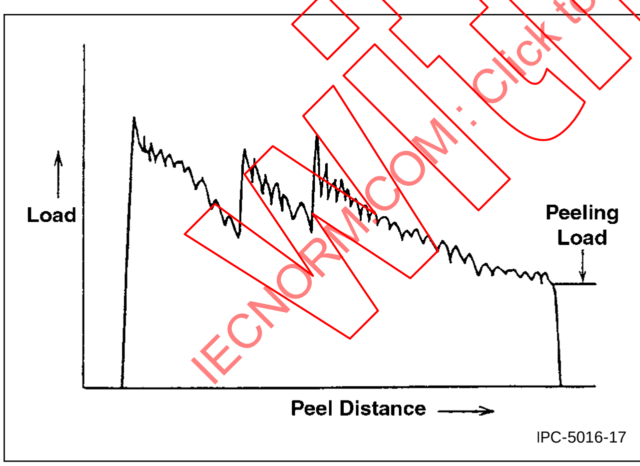

Figure 17 Peeling Mode without Stabilized Area

and take the minimum value so obtained as the peel strength (N/mm) of the specimen.

(e) Report the peel strength on both the longitudinal and lateral specimens.

8.1.6.2 Method B (Method of Peeling at 180°)

(a) Similar to method A, fix the specimen whose conductor width has been measured to the tensile tester as

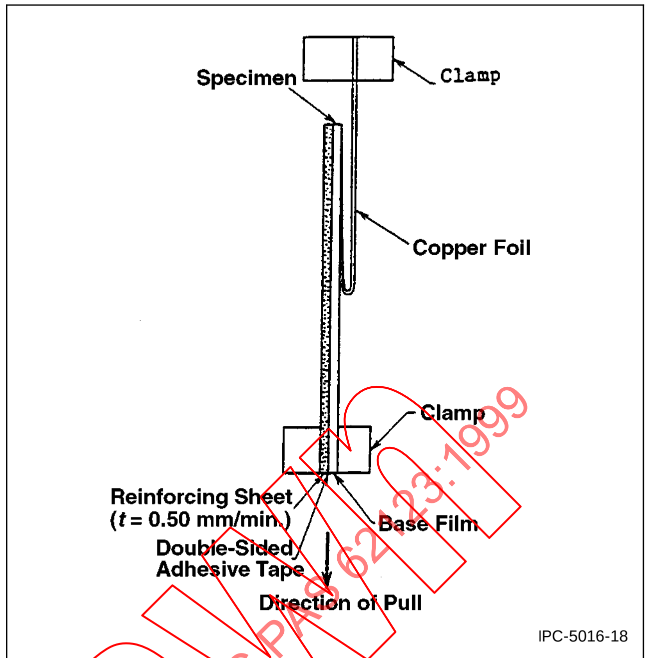

Figure 18 Method of Mounting Specimen for Measurement of Peel Strength by Method B (peeling in a direction at 180°C)

illustrated in Figure 18. At this fixing, to ensure peeling at 180°, paste the reinforcing sheet to the base film with double-sided adhesive tape so slip or uneven force will not appear.

(b) The following measurement procedures and the calculation method of the peel strength shall be the same as those in method A.

8.2 Pull-Off Strength of Land with Plain Hole

8.2.1 Equipment The equipment shall be as specified in 8.1.1 and 10.4.1.

8.2.2 Specimen The specimen shall be isolated circular lands, and the land, hole, and lead wire dimensions given in Table 2 are used as the standard. As illustrated in Figure 19, the wires and lands, which are preliminarily soldered with an adequate flux, using the solder H60A or H63A specified in JIS Z 3282, or RH60A or RH63A specified in JIS Z 3283 within three seconds by means of the equipment specified in 10.4.1, shall be used. If other dimensions are used, they shall be specified in the detail specification.

Table 2 Land, Hole and Wire Dimensions (mm)

Land diameter	Hole diameter	Wire diameter
4	1.3	0.9 to 1.0
2	0.8	0.6 to 0.7

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

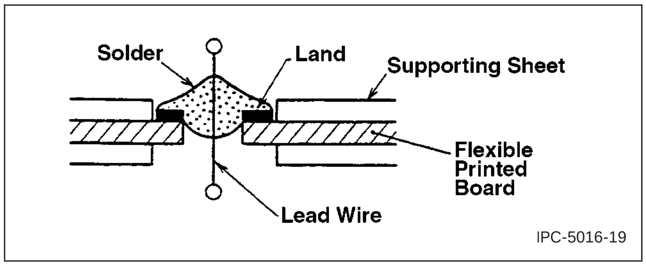

Figure 19 Specimen for Pull-Off Strength of Land with Plan Hole

8.2.4 Test

8.2.4.1 Insert a lead wire through the hole of the specimen so it projects a short length from the rear surface without bending and solder it with the solder specified in 8.2.2 to the land on the front surface. Carry out the soldering using a soldering iron (with a tip diameter 5 mm ± 0.1 mm) at a bit temperature of 270°C ± 10°C within three to five seconds, without making the iron in direct contact with the land. After soldering, allow the specimen to stand at room temperature for at least 30 minutes for cooling. Pull the lead wire by means of the tensile tester at 50 mm/minute perpendicular to the specimen, and measure the load when the land separates from the base material.

Do not consider the break or coming-out of the wire as a defect; carry out the retest.

8.4.2.2 When the pull-off strength of the land, which was repeatedly soldered is measured, remove the wire from the specimen prepared by 8.2.4.1 in the same way, and solder the new wire to the same land under the same conditions as those stated in 8.2.4.1. Repeat this removal and re-soldering of wire for the number of times specified in the detailed specification (cool the specimen every time), then allow the specimen to stand at room temperature for at least 30 minutes for cooling. Pull the wire by means of the tensile tester at 50 mm/minute perpendicular to the specimen and measure the load when the land separates from the base material.

Do not consider the break or coming-out of the wire as a defect; carry out the retest.

8.3 Pull-Off Strength of Foot Print

8.3.1 Equipment The equipment shall be as specified in 8.1.1 and 10.4.1.

8.3.2 Specimen The specimen shall be an isolated footprint. The dimensions of the footprint and size of the wire employed as the specimen are specified in the detailed specification (see Figure 20).

The wire and footprint, which are preliminarily soldered by using an adequate flux and the solder specified in 8.2.2 within three seconds by means of the equipment specified in 10.4.1, shall be used.

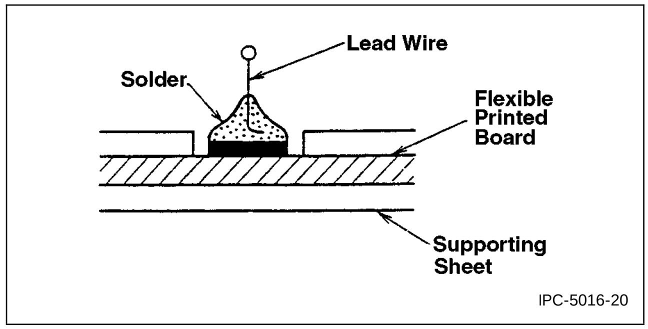

Figure 20 Specimen for Pull-Off Strength of Foot Print

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

8.3.4 Test

8.3.4.1 Let the wire vertically come in contact with the central part of the specimen and solder it by using the solder specified in 8.2.2. Carry out this procedure using a soldering iron (with a tip diameter 5 mm ± 0.1 mm) at a bit temperature of 270°C ± 10°C within three to five seconds without making the iron in direct contact with the foot print. After the soldering, allow the specimen to stand at room temperature for at least 30 minutes for cooling, pull the wire by means of the tensile tester at 50 mm/minute perpendicular to the specimen, and measure the load when the footprint separates from the base material.

Do not consider the break or coming-out of the wire as a defect; carry out the re-tests.

8.3.4.2 When the pull-off strength of the footprint, which was repeatedly soldered, is measured, remove the wire from the specimen prepared by the procedures of 8.3.4.1 in the same way, and solder the new wire to the same foot print under the same conditions as those stated in 8.3.4.1. Repeat this removal and re-soldering of the wire for the number of times specified in the detailed specification (cool the specimen every time), then allow the specimen to stand at room temperature for at least 30 minutes for cooling. Pull the wire by means of the tensile tester at 50 mm/minute perpendicular to the specimen and measure the load when the footprint separates from the base material.

Do not consider the break or coming-out of the wire as a defect; carry out the re-tests.

8.4 Adhesion of Plating

8.4.1 Material to be Used for Test The material for the test shall be the transparent pressure sensitive adhesive tape specified in JIS Z 1522 (hereafter referred to as ''tape'') with a width of 12 mm or 24 mm.

8.4.2 Specimen The specified part of the flexible printed board shall be employed as the specimen.

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

8.4.4 Test Adhere the new adhesive surface of the tape to the cleaned surface of the specimen through a length ≥50 mm using finger pressure or some other suitable method so that no air bubbles remain. After about 10 seconds, quickly peel off the tape parallel to the plated surface. The total area to be tested shall be 1 cm^2 minimum. Examine for the existence or non-existence of separation of the plated film from the base and adhesion of the plated film to the tape, as specified in 6.1. However, the plated film separated from the overhung portion of plating is not the subject of this test.

8.5 Adhesion of Solder Resist and Symbol Mark

8.5.1 Peel Strength by Tape

8.5.1.1 Material to be Used for Test The material to be used for the test shall be as specified in 8.4.1.

8.5.1.2 Specimen The specimen shall be a flexible printed board to which the solder resist and symbol mark are applied.

8.5.1.3 Preconditioning The preconditioning shall be as specified in Section 5. When the adhesion on the specimen subjected to other tests is examined, the detailed specification shall specify the details.

8.5.1.4 Test Adhere the new adhesive surface of the tape to the cleaned surface of the specimen through a length ≥50 mm by finger pressure or some other suitable method so that no air bubbles remain. After about 10 seconds, quickly peel off the tape perpendicular to the printed surface. Examine for the existence or non-existence of separations of the solder resist or symbol mark and transfer of printed film to the tape side in accordance with 6.1.

8.6 Resistance to Flexural Fatigue

8.6.1 Equipment A flexural fatigue tester as shown in Figure 21 shall be used.

8.6.2 Specimen The flexible printed board, test coupon, or test pattern of Figure 3 shall be used as the specimen, and at least six specimens with coverlay shall be prepared.

8.6.3 Test Attach insulated wires to the terminations of the conductor pattern of the specimen, mount the specimen to the flexural fatigue tester so the radius of flexure (outer periphery) specified in the detailed specification appears, and connect the wires to the relay box. Set the travel of the specimen (stroke) to preclude the bending of the specimen at its fixed point, repeat the reciprocating motion of sliding bar at a rate specified in the detail specification, and examine the number of flexures until the current flowing through the conductor pattern interrupts.

8.7 Resistance to Bending

8.7.1 Equipment The bending tester as shown in Figure 22 shall be used.

8.7.1.1 The clamp, which applies load to the specimen, shall be structured so it moves perpendicular to the rotating axis of the bending device, its specimen mounting face is in the plane passing the rotating axis, and it can apply a tension of 0 N to 14.7 N, as specified in the detailed specification.

The distance of the clamp from the rotating axis while the specimen is loaded shall be 50 mm to 75 mm.

8.7.1.2 The bending device shall have two smooth and parallel bending surfaces positioned symmetrically to its rotating axis.

The rotating axis shall be positioned in a plane tangential to the two bending surfaces and at the center of the two surfaces. The bending device shall be equipped with a clamp, the motion of which can bend the specimen through an angle of 135° ± 5° right and left of the neutral position.

Each bending surface shall have the radius of the curvature specified in the detailed specification, and its length shall not exceed 19 mm. The gap between the bending surfaces is necessary to have a distance larger than the thickness of the specimen but shall not exceed the thickness of the specimen not being compressed by more than 0.25 mm.

8.7.1.3 The equipment shall have a driving mechanism, which gives the bending device a constant rotational motion.

8.7.1.4 The equipment shall have a device that indicates the number of reciprocating bends.

8.7.2 Specimen The flexible printed board, test coupon, or test pattern of Figure 4 shall be used as the specimen, and at least six specimens with coverlay shall be prepared.

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

8.7.4 Test Apply a load corresponding to the tension necessary for the specimen and stop the plunger at that position. Attach the specimen correctly so the specimen forms a plane and does not come in contact with the mounting surface of the bending device. Handle the specimen at both ends so as not to touch the bending part. Apply

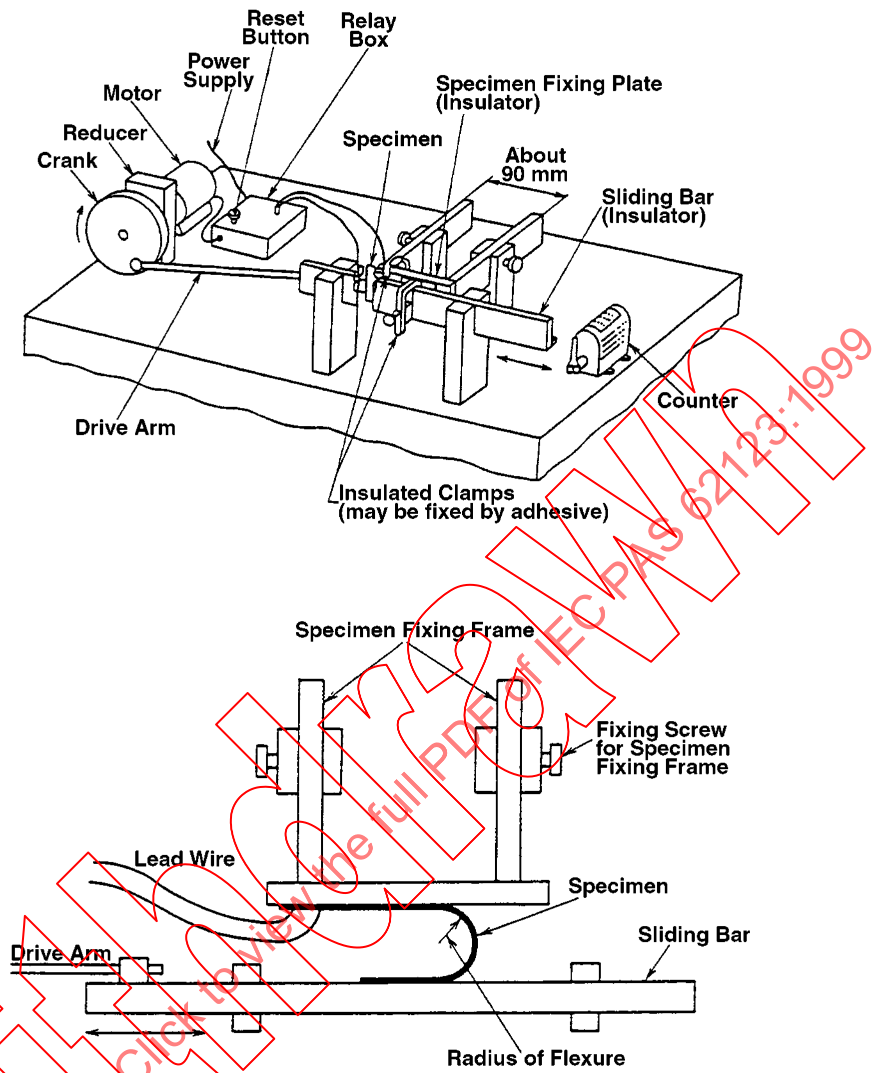

Figure 21 Example of Flexural Fatigue Tester

the load by loosening the fixing screw of the plunger. If the reading of the load indicator changes, adjust the load by the adjusting screw so the reading coincides with that at previous loading. The radius of the curvature of the bending surface shall be agreed upon between the parties concerned with the acceptance. Bend the specimen at a tension 4.9 N and a rate of about 170 bends/minute and measure the number of bends until the specimen causes breakage of conductor.

9 CLIMATIC TESTS

9.1 Cyclic Temperature Change

9.1.1 Equipment The test chamber shall consist of a low temperature chamber and a high temperature chamber and shall be capable of adjusting and maintaining the temperatures to those shown in Table 3. However, one test chamber system is allowed.

9.1.2 Specimen The specimen shall be the specified part of the test coupon, test pattern, or flexible printed board appropriate to the test item specified in the detail specification.

9.1.3 Test Measure the specimen for the test items specified in the detailed specification, select the temperature conditions from Table 3 as specified in the detailed specification, and subject the specimen to the temperature change of the cycles specified in the detailed specification, counting the operations of cycle steps 1 through 4 as one cycle. If the number of cycles is not specified in the detail specification, carry out five cycles. Then carry out the measurement on the specified items.

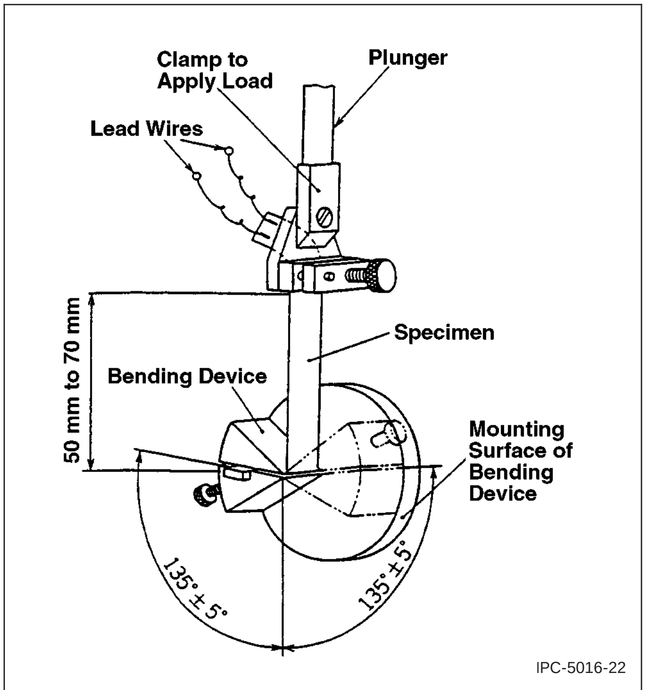

Figure 22 Example of Bending Tester

9.2 Thermal Shock (Low Temperature and High Temperature)

9.2.1 Equipment The test chamber shall consist of a low temperature maintaining the temperatures to those shown in Table 4; however, one test chamber system is allowed.

9.2.2 Specimen The specimen shall be as specified in 9.1.2.

9.2.3 Test Measure the specimen for the test items specified in the detailed specification, select the temperature conditions from Table 4 as specified in the detailed specification, and subject the specimen to the thermal shock conditions of step 1 and step 2, then quickly from step 2 to step 1 for the cycles specified in the detailed specification. If the number of cycles is not specified in the detailed specification, carry out five cycles.

Allow the specimen to stand for sufficient time to stabilize at the temperature of the standard conditions specified in 3.1, then carry out the measurements on the specified items.

9.3 Thermal Shock (Immersion, Hot Bath)

9.3.1 Equipment The equipment shall satisfy the following requirements:

- A vessel containing sufficient silicone oil or the like to immerse the specimen, the temperature of which can be maintained at 260°C +5°C, -0°C.
- A vessel containing sufficient organic solvent such as 2-propanol to immerse the specimen, the temperature of which can be maintained at 20°C ± 15°C.

9.3.2 Specimen The specimen shall be as specified in 9.1.2.

9.3.3 Test Measure the specimen for the test items specified in the detailed specification, then subject the specimen to the thermal shock of the cycles of Table 5, as specified in the detailed specification. The operations of cycle steps 1 through 4 are counted as one cycle; if the number of cycles is not specified in the detail specification, carry out five cycles.

Allow the specimen to stand for sufficient time to stabilize at the temperature of the standard conditions specified in 3.1 and then carry out the measurements on the specified item.

Table 3 Conditions for Cyclic Temperature Change

Step		Condition 1		Condition 2		Condition 3	
		Temperature °C	Duration minutes	Temperature °C	Duration minutes	Temperature °C	Duration minutes
Cycle	1	-65 ± 3	30	-65 ± 3	30	-55 ± 3	30
	2	20 ± 15	10 to 15	20 ± 15	10 to 15	20 ± 15	10 to 15
	3	125 ± 3	30	125 ± 3	30	100 ± 2	30
	4	20 ± 15	10 to 15	20 ± 15	10 to 15	20 ± 15	10 to 15

Table 4 Conditions for Thermal Shock Test

Step	Condition 1		Condition 2		Condition 3		Condition 4	
	Temperature °C	Duration minutes	Temperature °C	Duration minutes	Temperature °C	Duration minutes	Temperature °C	Duration minutes
Step 1	-65 ± 3	30	-65 ± 3	30	-65 ± 3	30	-55 ± 3	30
Step 2	175 ± 3		125 ± 3		100 ± 2		100 ± 2	

Table 5 Test Conditions

Step		Temperature °C	Duration min	Immersing liquid
Cycle	1	260 +5 -0	Three to five	Silicone oil or the like
	2	20 ± 15	Within 15	(Transfer)
	3		20	2-propanol or the like
	4		Within 15	(Transfer)

9.4 Resistance to Dampness, Heat (Cyclic) (See JIS C 0028)

9.4.1 Equipment The equipment shall be a chamber that satisfies the following requirements:

- The chamber shall be capable of adjusting the inside atmosphere to the cyclic damp heat condition illustrated in Figure 23.
- If the chamber is humidified by a direct spray of water, the resistivity of the water shall not be <500 m.
- The water condensed on the internal wall and ceiling of the chamber shall not fall on the specimen or in the vicinity of specimen.

9.4.2 Specimen The specimen shall be a printed board, test pattern, etc.

9.4.3 Test Measure the specimen for the test items specified in the detailed specification, put it in the chamber, and continuously subject it to the damp heat of the cycles specified in the detailed specification. If the number of cycles is not specified, carry out 10 cycles.

Count the operations of steps a through g in Figure 23 as one cycle and carry out this cycle in 24 hours. Carry out the procedures in step g in the last cycle (measurement at high humidity, measurement immediately after taking out of the chamber and measurement after drying) as specified in the detailed specification. Carry out the measurements on the items specified in the detailed specification.

Do not use the specimen on which mechanical damage, flashover, sparkover, or breakdown take place in this test for any other tests.

9.5 Resistance to Dampness, Heat (Steady State) (see JIS C 0022)

9.5.1 Equipment The equipment shall be a test chamber that satisfies the following requirements:

- The chamber can maintain its internal temperature at 40°C ± 2°C and 90% H to 95% H.
- If a direct spray of water humidifies the chamber, the resistivity of the water shall not be <500 m.
- The water condensed on the internal wall and ceiling of the chamber shall not fall on the specimen or in the vicinity of specimen.

9.5.2 Specimen The specimen shall be as specified in 9.4.2.

9.5.3 Test Place the specimen in the chamber at 40°C ± 2°C and 90% RH to 95% RH, as specified in 9.5.1, and allow it to stand in the chamber for the duration specified in the detailed specification. If the duration is not specified, it shall be 96 +2, -0 hours.

In this procedure, take care of the arrangement of the chamber and accessories, such as the support of the specimen. Also take suitable means, so the specimen is preheated to the inside temperature of the chamber then put into the chamber so the specimen does not sweat and no water drops fall on the specimen.

Take the specimen out of the chamber, quickly and completely remove the water drops adhering on the surface, if any, then carry out the measurement for the items specified in the detail specification.

Do not use the specimen on which mechanical damage, flashover, or dielectric breakdown takes place in this test for other tests.

10 OTHER TESTS

10.1 Flammability Flammability shall be as specified in 6.8 of JIS C 6471.

10.2 Resistance to Thermal Shock of Copper Plated-Through Hole

10.2.1 Equipment The measuring equipment shall be capable of measuring the resistances of the PTHs within ± 5% and be as prescribed in the following.

- Measuring equipment by voltage drop method as shown in Figure 10
- Contact resistance tester, Kelvin bridge, contact resistance meter, etc.

10.2.2 Specimen The test pattern of Figure 5 employing a film as the base specified in the detail specification shall be used.

10.2.3 Preconditioning The specimen shall be stored in a dryer of a forced circulation system maintained at 105°C for at least one hour.

10.2.4 Test Take the specimen out of the dryer, connect the terminations of the specimen to the measuring terminals of measuring apparatus, and measure the initial value (w_1) of the resistance of the PTH.

Immerse it in peanut oil or some other oil at 260°C ± 5°C for 5 +1, -0 seconds, then cool it to room temperature. Repeat this step five times, then clean it with 2-propanol,

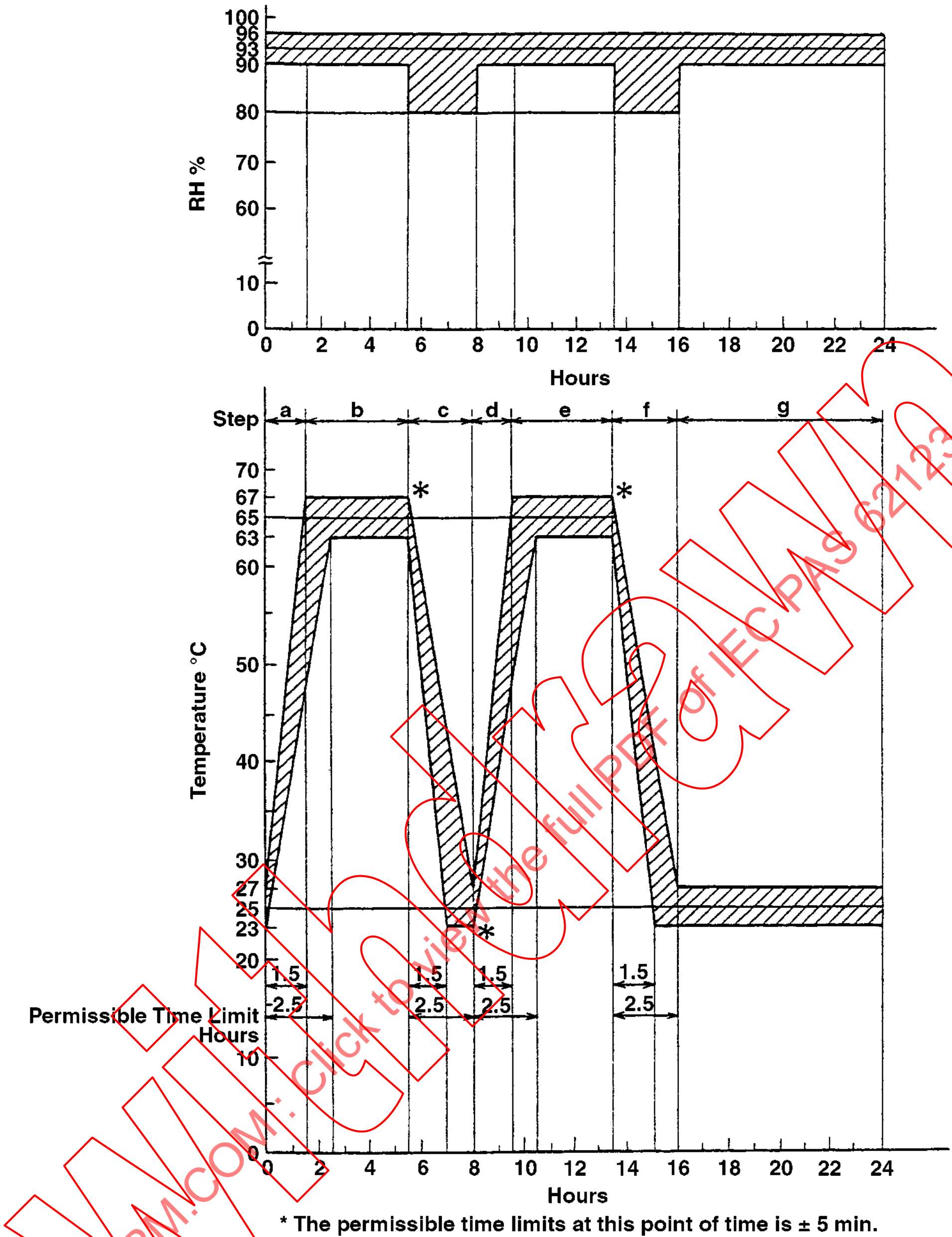

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Figure 23 Damp, Heat Cycle

measure the value (w_2) of resistance of PTH, and calculate the relative variation of resistance $\frac{\Delta}{R}$ (%) from the following formula:

$$\frac{\Delta R}{R} = \left| \frac{w_2 - w_1}{w_1} \right| \text{x } 100$$

where: w_1: initial resistance of PTH (Ω)

w_2: resistance of PTH after test (Ω)

10.3 Resistance to Soldering Heat

10.3.1 Equipment The equipment shall be as follows:

- A bath that can contain molten solder specified in 10.4.4 to a depth ≥50 mm and can control the temperature of solder at a specified position within tolerances of ± 3°C over 200°C to 300°C
- Thermocouple thermometer or L type mercury thermometer graduated by ± 1°C over 200°C to 300°C

10.3.2 Specimen The specimen shall be the flexible printed board, test coupon, or as stated in 10.3.2.1 through 10.3.2.4.

10.3.2.1 For the base material of single-sided flexible printed boards, two specimens employing the test pattern of Figure 6 shall be prepared. For the case of double-sided flexible printed boards, four specimens employing the test pattern of Figure 7 shall be prepared.

10.3.2.2 For coverlay of single-sided flexible printed boards, two specimens employing the test pattern of Figure 6 and having the coverlay throughout the surface of one side shall be prepared. For the case of double-sided flexible printed boards, four specimens employing the test pattern of Figure 7 and having the coverlay throughout the surfaces of both sides shall be prepared.

10.3.2.3 For the covercoat of single-sided flexible printed boards, two specimens employing the test pattern of Figure 6 and having the covercoat throughout the surface of one side shall be prepared. For the case of double-sided flexible printed boards, four specimens employing the test pattern of Figure 7 and having the covercoats throughout the surfaces of both sides shall be prepared.

10.3.2.4 For symbol markings of single-sided flexible printed boards, two specimens, which have the test pattern of Figure 8, are treated as specified in 10.3.2.2 and marked with the symbol shall be prepared. Two specimens of the same pattern treated as specified in 10.3.2.3 and marked with the symbol shall be prepared. The printing of the symbol mark for double-sided flexible printed boards may be done on either one side.

10.3.3 Preconditioning The specimen shall be stored in a dryer of a forced circulation system maintained at 105°C ± 5°C for at least one hour.

10.3.4 Test

10.3.4.1 Take the specimen out of the dryer, quickly float it on the molten solder specified in 10.4.4 maintained at 260°C ± 5°C for 5 +l, -0 seconds, pick it up, and visually examine the items specified in the detailed specification.

Test the single-sided flexible printed boards by floating the specimen on the molten solder with the base film upwards. In the case of double-sided flexible printed boards, carry out the test on each of the specimens of two kinds, one floated with its front downwards and another with its rear downwards.

10.3.4.2 For coverlay, carry out the same test as that of 10.3.4.1 and visually examine the items specified in the detail specification.

10.3.4.3 For covercoat, carry out the same test as that of 10.3.4.1, cut the coat to the surfaces of the base film without copper foil, and of copper foil to prepare 100 squares of about 1 mm in a lattice form. Adhere the pressure sensitive adhesive cellophane tape specified in JIS Z 1522 having a width of 12 mm or 24 mm by finger pressure. About 10 seconds later, quickly peel off the tape parallel to the specimen and visually examine the items specified in the detailed specification.

10.3.4.4 For symbol marking, carry out the same test as that of 10.3.4.1, then visually examine the items specified in the detailed specification.

10.4 Solderability

10.4.1 Equipment The equipment shall be a molten solder bath, the temperature of which can be controlled and maintained.

10.4.2 Specimen The specimen shall be the flexible printed board or test coupon.

10.4.3 Preconditioning The specimen shall be stored in a dryer of a forced circulation system maintained at 105°C ± 5°C for ≥1 hour.

10.4.4 Test Paste the specimen with the flux. Unless otherwise specified in the detail specification, the flux shall be one of those specified in the following:

Flux (1): Flux consisting of 25% of the colophonium specified in JIS K 5902 and 75% of the 2-propanol specified in JIS K 8839 or of ethanol specified in JIS 8101, in mass ratio

Flux (2): Flux in which diethyl ammonium chloride (reagent grade) is added to the flux of (1) so that the chlorine content (indicated by ratio of free chlorine to colophonium content) becomes 0.2% in mass ratio

Flux (3): Such a flux that the chlorine content is increased to 0.5% in mass ratio in the flux of (2)

Immerse the specimen vertically in the molten solder (H60A or H63A specified in JIS Z 3282) maintained at 235°C ± 5°C at a rate of 25 mm ± 5 mm per second and maintain it for 5 ± 0.5 seconds. Raise the specimen at a rate of 25 mm ± 5 mm per second, clean the surface of specimen with clean organic solvent (e.g. 2-propanol) and examine the following matters under sufficient illumination using a magnifier:

- Wetting by solder, brightness
- Existence or nonexistence of de-wetting by solder, pinhole
- Wetting condition by solder in through hole

10.5 Resistance to Chemicals

10.5.1 Specimen The specimen shall be as specified in 10.3.2.

10.5.2 Test

10.5.2.1 For base materials, immerse the specimen into each of the chemicals for 5 minutes ± 30 seconds and visually confirm the appearance.

The chemicals shall be hydrochloric acid (2 mol/l) as acid, aqueous solution of sodium hydroxide (2 mol/l) as alkali, and 2-propanol as alcohol.

10.5.2.2 For coverlay and covercoat, immerse the specimen for 5 minutes ± 30 seconds into 2-propanol at room temperature, pick it up, then visually confirm the appearance.

10.5.2.3 For symbol marking, carry out the same test as that of 10.5.2.2, then visually confirm the appearance.

JIS C 5017-1994
Flexible Printed Wiring Boards — Single-Sided, Double-Sided

1 SCOPE

This Japanese Industrial Standard specifies single- and double-sided flexible printed wiring boards (PWBs), used mainly for electronic apparatus (hereafter referred to as flexible printed boards).

The flexible printed boards dealt with here are single-sided flexible printed boards having polyester film or polyimide film as the base material and double-sided flexible printed boards having polyimide film as the base material, which are manufactured using copper-clad laminate, in accordance with subtractive process.

Remarks 1. The following standards are cited in this Standard:

JIS C 5016 Test Methods for Flexible Printed Wiring Boards

JIS C 5603 Terms and Definitions for Printed Circuits

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

2. The International standards corresponding to this Standard are given below:

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

2 DEFINITIONS

For the purposes of this Standard, in addition to the definitions specified in JIS C 5603, 2.1 through 2.3 apply.

2.1 Adhesive Flow The ooze of adhesive on the conductor surface such as lands due to bonding of coverlay by means of heat and pressure.

2.2 Reinforcing Material The laminated sheet, plastic sheet, or metal sheet to be bonded to a part of a flexible printed board by using an adhesive or pressure sensitive adhesive, to give rigidity to that part or to fix the board at the part.

2.3 Filiform Burr The filiform burr produced during machining.

3 CHARACTERISTICS

The characteristics of flexible printed boards, the test items, and applicable test methods shall be as given in Table 1.

Note: The test methods are based on JIS C 5016.

Table 1 Characteristics and Test Methods

No.	Item	Characteristics	Test method (JIS C 5016)
1	Insulation resistance of surface layer	Shall be 5 x 10^8 Ω or over.	As specified in 7.6
2	Voltage proof of surface layer	Shall not make flashover by AC. applied voltage of 500 V.	As specified in 7.5
3	Peeling strength	Shall be 0.49 N/mm or more.	As specified in 8.1
4	Plating adhesion	Shall not be peeled off.	As specified in 8.4
5	Solderability	To show superior solderability on 95% or more of soldered area. However, it is not applicable for the flexible printed board employing polyester film as its base.	As specified in 10.4
6	Resistance to flexural fatigue	Flexible printed board with coverlay shall satisfy the number of flexures at the flexing radius determined by the agreement between the parties concerned with acceptance.	As specified in 8.6
7	Resistance to bend	Flexible printed board with coverlay shall satisfy the number of bends under the radius of curvature at the bending part and load determined by the agreement between the parties concerned with acceptance.	As specified in 8.7

No.	Item	Characteristics	Test method (JIS C 5016)
8	Climates resistance	Specimens shall be tested under the conditions selected from the test methods in the following column, determined by the agreement between the parties concerned with acceptance, and shall comply with the characteristics of each test item, before and after this test.	As specified in 9.1, 9.2, 9.3, 9.4 and 9.5
9	Resistance to thermal shock of copper plated through hole	Relative change in resistance of PTHs of double-sided flexible printed boards shall not be >20	As specified in 10.2
10	Resistance to burning	Specimen resistance to burning shall satisfy the appropriate value given below after this test Item — Criterion (1) Duration of flaming — Within 10 seconds at each test; Total duration of both burning at second test shall be within 30 seconds (2) Duration of flaming and glowing — Total duration of both burning at second test shall be within 30 seconds (3) Flaming or glowing to the grip or bench mark — No such burning (4) Drip that ignites absorbent cotton — No such drip Remarks: In such cases that only one specimen out of five in the above (1 through 4) does not satisfy criteria, or that total duration of flaming in 10 tests is 51 seconds to 55 seconds, retest shall be carried out. In the retest, all the specimens shall satisfy the criteria.	As specified in 6.8 of JIS C 6471
11	Resistance to soldering heat	There shall be no blister or peel off. On the covercoat, there shall be no discoloration harmful to practical use. There shall be no remarkable defect on symbol mark. This test is not applicable to flexible printed boards employing polyester film as their base.	As specified in 10.3
12	Resistance to chemicals	There shall be no blister or peel off. There shall be no remarkable defect on symbol mark.	As specified in 10.5

4 DIMENSIONS

4.1 Grid Dimensions

4.1.1 Basic Grid As for grids of flexible printed boards, the Metric system shall be used as the standard, and the Imperial system shall be used only when compatibility with traditional product is necessary.

The basic grid dimensions shall be as follows:

Metric system

2.50 mm Imperial system: 2.54 mm

4.1.2 Auxiliary Grid If grid dimension smaller than that of basic grid of 4.1.1 is necessary, the following dimensions shall be used:

Metric system: Unit of 0.5 mm (if further smaller unit is necessary, 0.05 mm shall be used)

Imperial system: 0.635 mm

Remarks: Grids of any unit smaller than 0.05 mm or 0.635 mm shall not be used.

4.2 External Dimensions

4.2 External Dimensions The external dimensions shall be the dimensions specified separately by agreement between the parties concerned with acceptance. The tolerances on external dimensions shall be ± 0.3 mm for an external dimension <100 mm and ± 0.3 % for that ≥100 mm.

4.3 Hole

4.3.1 Hole Diameter and Tolerance

4.3.1.1 Component Hole In flexible printed boards, the minimum component hole diameter shall be 0.50 mm and the tolerances shall be 0.08 mm.

4.3.1.2 Via In double-sided flexible printed boards, the plated-through hole used for via shall be a circular hole only. The minimum hole diameter after plating shall be 0.50 mm and the tolerances shall be ± 0.08 mm.

4.3.1.3 Mounting hole

Circular Hole The minimum diameter of a circular hole shall be 0.50 mm and the tolerances shall be ± 0.08 mm.

Square Hole The minimum dimensions of one side of the square hole shall be 0.50 mm and the tolerances shall be ± 0.08 mm.

4.3.2 Minimum Distance Between Mounting Hole End and Board End The minimum distance between the mounting hole end and board end shall not be <2.0 m.

4.3.3 Misalignment of Hole Position The misalignment of a finished hole position and the designed hole position shall be ≤0.3 mm. Vias are excluded.

4.3.4 Center Distance of Holes The tolerances on the center distance of holes shall be ± 0.3 mm for a distance <100 mm and ± 0.3 % of center distance of holes for ≥ 100 mm.

4.4 Conductor

4.4.1 Tolerance of Finished Width From Design Conductor Width The tolerance of the finished width from the design conductor width shall be as given in Table 2.

Table 2 Tolerance of Finished Width (mm)

Design Conductor Width (w)	Tolerance
$w \leq 0.10$	± 0.05
$0.10 < w < 0.30$	± 0.08
$0.30 \leq w < 0.50$	± 0.10
$0.50 \leq w$	± 20 %

4.4.2 Tolerance of Finished Spacing From Design Spacing Between Conductors The tolerance of finished spacing from design spacing between conductors shall be as given in Table 3.

Table 3 Tolerance of Finished Spacing (mm)

Minimum Design Spacing Between Conductors (s)	Tolerance
$w \leq 0.10$	± 0.05
$0.10 < w < 0.30$	± 0.08
$0.30 \leq w < 0.50$	± 0.10
$0.50 \leq w$	± 20%

4.4.3 Minimum Distance Between Board End and Conductor End The design minimum distance between board end and conductor end shall not be <0.5 mm.

4.5 Land

4.5.1 Minimum Land Width As shown in Figure 1, the minimum land width (d) effective for soldering after finishing shall not be <0.05 mm.

4.6 Thickness of Copper Plated-Through Hole The thickness of plating on the inner wall of copper plated-through holes shall be such that the average thickness of plating is not <0.015 mm and the minimum thickness of plating is not <0.008 mm.

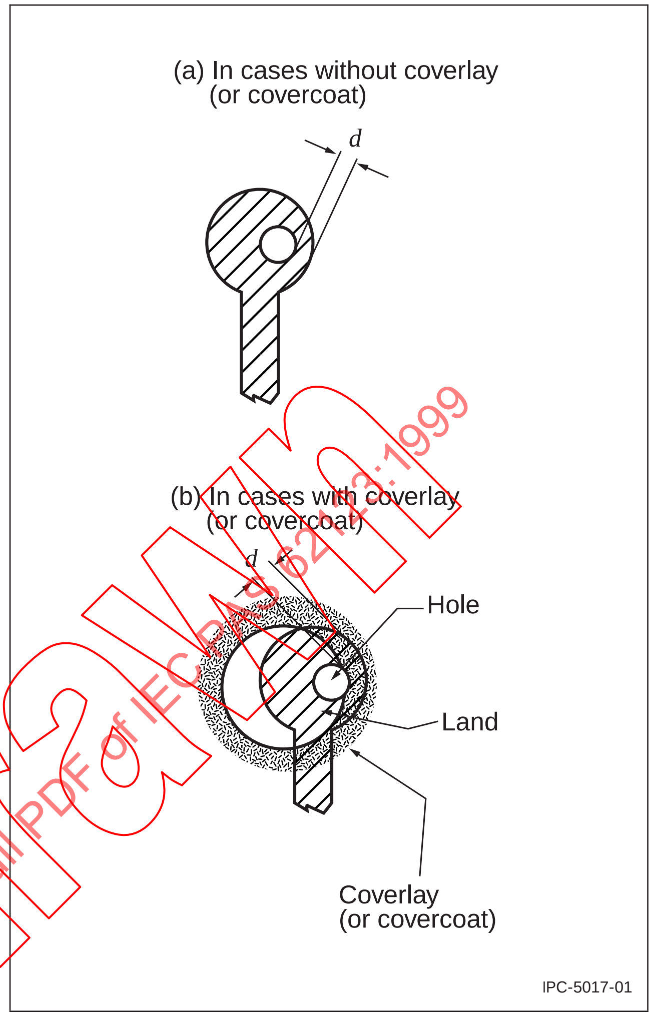

Figure 1 Effective Minimum Land Width

5 APPEARANCE

5.1 Appearance of Conductors

5.1.1 Disconnection There shall be no disconnection.

5.1.2 Void and Pinhole The width of the lack of conductors (w_1) due to a void or pinhole, as illustrated in Figure 2, shall not be > 1/3 of the conductor width after finishing (w), and the length of defect (l) shall not be more than the conductor width after finishing (w).

5.1.3 Residual Conductor in Spacing Between Conductors The width of residual or projection of conductors (w_1) illustrated in Figure 3 shall not be > 1/3 of the spacing between conductors after finishing (w).

5.1.4 Etching on Conductor Surface The recess of surface due to etching, as illustrated in Figure 4, shall not lie throughout the lateral direction of the conductor.

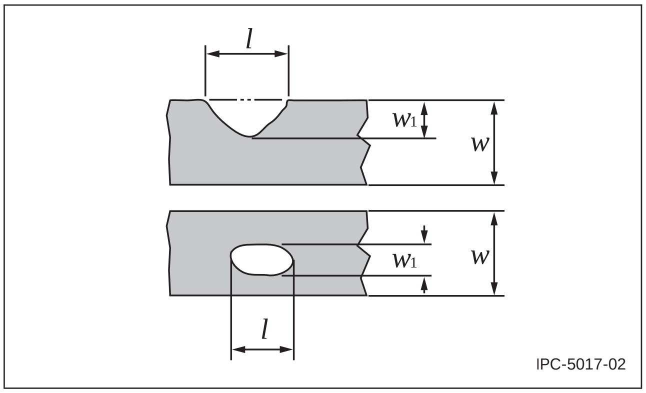

Figure 2 Void and Pinhole

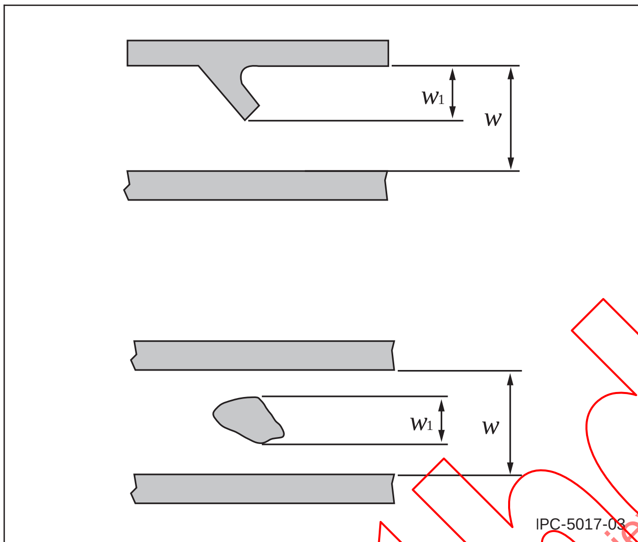

Figure 3 Residual Conductor in Spacing Between Conductors

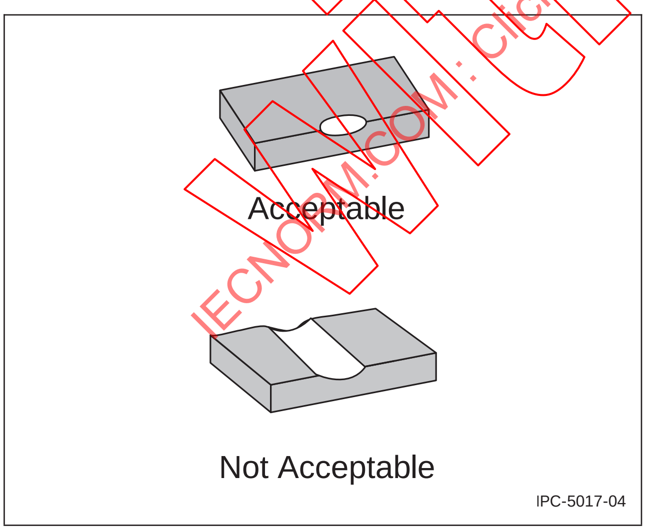

Figure 4 Surface Etching

5.1.5 Separation of Conductors The width (a) and length (b) of conductor separation, illustrated in Figure 5, shall be as stated in the following relative to the conductor width after finishing (w). For the part subjected to repeated bending, bending characteristics shall not be affected.

(1) Portion with coverlay

Under $b \leq w$, movable flexural portion : $\frac{a}{w} \leq \frac{1}{3}$

general portion : $\frac{a}{w} \leq \frac{1}{2}$

(2) Portion without coverlay

$\frac{a}{w} \leq \frac{1}{4}, \frac{b}{w} \leq \frac{1}{4}$

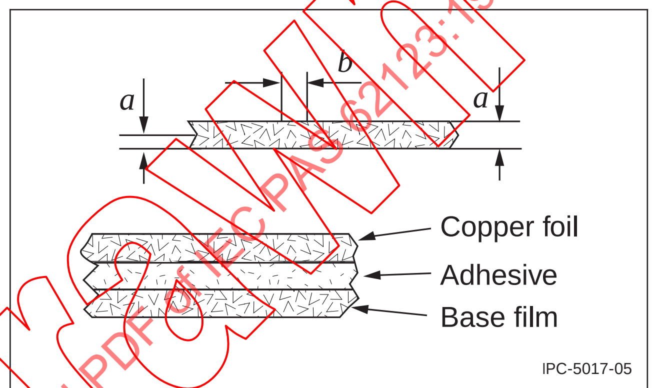

Figure 5 Separation of Conductor

5.1.6 Crack of Conductor There shall be no crack of conductors.

5.1.7 Bridge of Conductor There shall be no bridge of conductors.

5.1.8 Polishing Scratch of Conductors The depth of scratches due to polishing with a brush or the like shall not be >20% of the conductor thickness. For the portion subjected to repeated bending, the flexural characteristics shall not be affected.

5.1.9 Dent (Recess by Pressure) The dent illustrated in Figure 6 shall be such that the depth from the surface is within 0.1 mm. If the measurement of depth is difficult, the height (c) of projection of the rear surface of the base film may be considered equivalent to the depth.

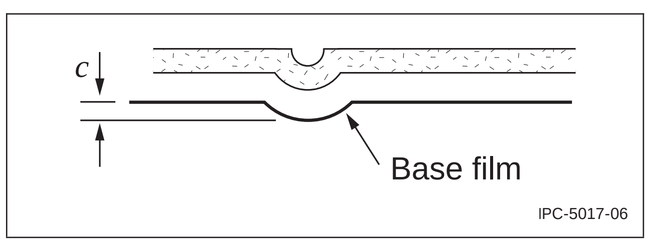

Figure 6 Dent

5.2 Appearance of Film Surface The permissible range of defects in appearance of the film surface where no conductor exists shall be as given in Table 4. Further, there shall be no unevenness, fold, wrinkle, or adhesion of foreign substances detrimental to practical service.

Table 4 Permissible Range of Defects on Film Surface

Defect	Permissible Range of Defects
Dent	The depth of dents shall be within 0.1 mm from the surface. Further, the film shall be free from sharp dents, splits, tears, and separations of adhesive layer.
Scratch	The depth of scratches due to polishing with a brush or the like shall not be >20% of the film thickness. For the portion subjected to repeated bending, the flexural characteristics shall not be affected.

5.3 Appearance of Coverlay and Covercoat

5.3.1 Defects in Appearance of Coverlay and Covercoat The permissible range of defects in appearance of the bonded coverlay and covercoat shall be as given in Table 5. Further, there shall be no unevenness, folds, wrinkles, or separations.

Table 5 Defects in Appearance of Coverlay and Covercoat

Defect	Permissible Range of Defects
Dents	The depth of dents shall be within 0.1 mm from the surface. The film without others shall be free from the cut. Further, the cover shall be free from sharp dents, tears, and separations of the adhesive layer.
Bubbles	The length of bubbles (*l*), as illustrated in Figure 7, shall not be >10 mm, and there shall be no bubbles that cross over two or more conductors. For the portion subjected to repeated bending, the flexural characteristics shall not be affected.
Foreign Substance	The conductive foreign substance shall be as specified in the residual conductor in spacing between conductors (see 5.1.3). As illustrated in Figure 8, there shall be no non-conductive foreign matters that cross over three or more conductors. For the portion subjected to repeated bending, the flexural characteristics shall not be affected.
Scratches	The depth of scratches due to polishing with a brush or the like shall not be > 20% of the film thickness. For the portion subjected to repeated bending, the flexural characteristics shall not be affected.

5.3.2 Misalignment of Land and Coverlay (or Covercoat) For misalignment of land and coverlay (or covercoat) (*e*), as illustrated in Figure 9, the tolerance is within ± 0.3 mm when the external dimension of the board is <100 mm, or within ± 0.3 % when the external dimension is ≤100 mm.

5.3.3 Adhesive Flow and Covercoat Blur The adhesive flow and covercoat blur (*f*) illustrated in Figure 10 shall not

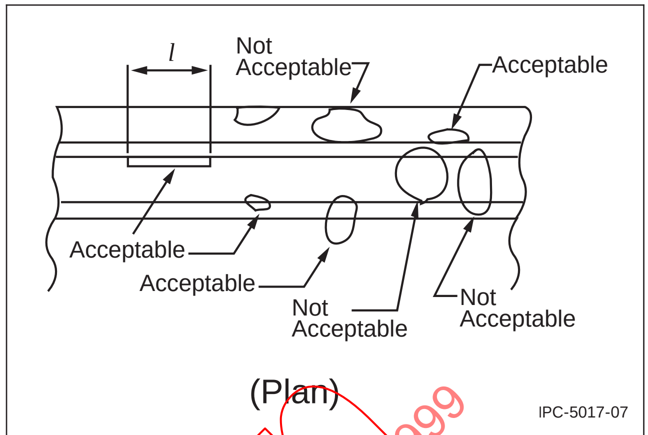

Figure 7 Bubble

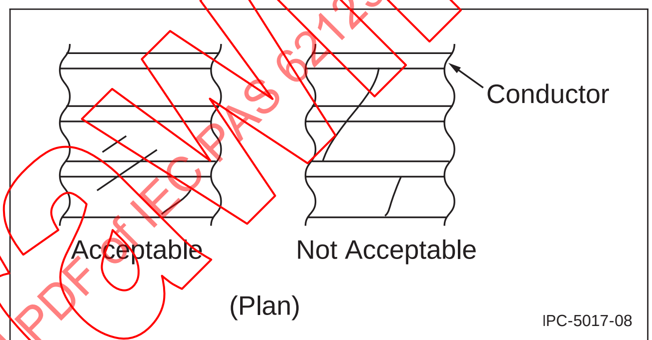

Figure 8 Non-Conductive Foreign Substance

be >0.3 mm. In the land part, the minimum effective land width ($g \geq 0.05$ mm) due to misalignment in bonding the coverlay and punching the hole shall be satisfied.

5.3.4 Discoloration (Conductor Under Coverlay) If there is discoloration of conductor covered by coverlay, the specimen shall satisfy the voltage proof, resistance to bend, resistance to fold, and resistance to soldering heat stated in this Standard after the damp test at 40°C, 90 % RH for 96 hours.

5.3.5 Covercoat Blur The blur of covercoat illustrated in Figure 11 shall be such that the solder does not adhere on a part of the conductor where the covercoat is blurred when the test specified in 10.4 of JIS C 5016 is carried out.

5.4 Appearance of Plating

5.4.1 Imperfection of Plating The width (w_1) and length (*l*) of imperfections of plating, as illustrated in Figure 12, shall be as given in Table 6, relative to the conductor width after finishing (*w*). The reliability of the contact part shall not be impaired due to imperfection of soldering.

5.4.2 Permeation of Plated Metal or Solder The part of the plated metal or solder (*h*) permeated between the conductor and the coverlay (or covercoat), as illustrated in Figure 13, shall not exceed 0.5 mm.

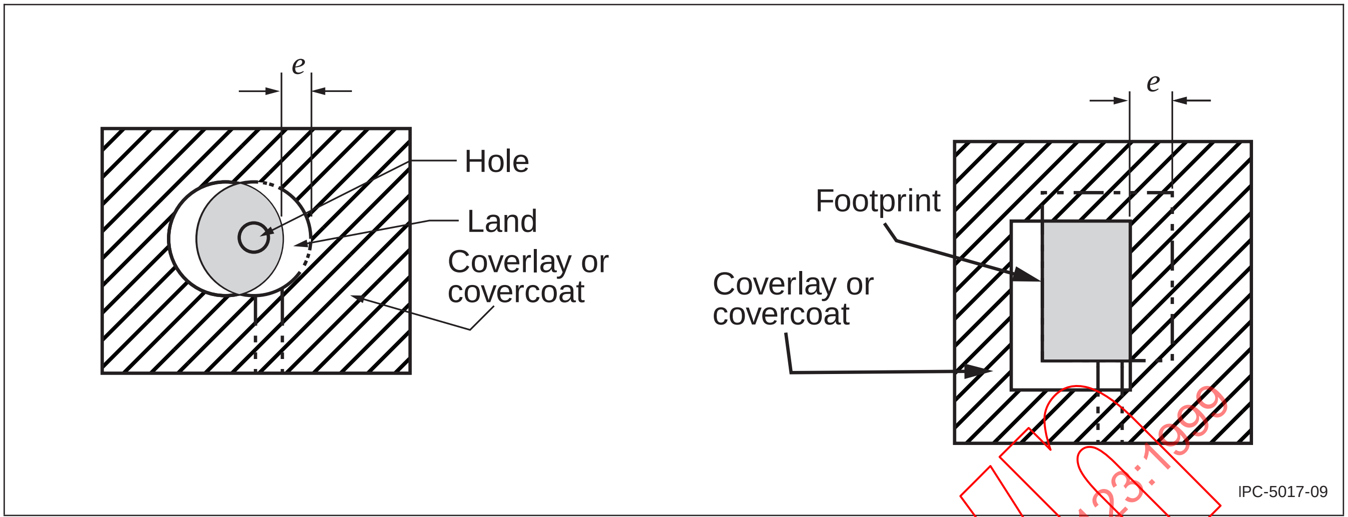

Figure 9 Misalignment of Coverlay or Covercoat

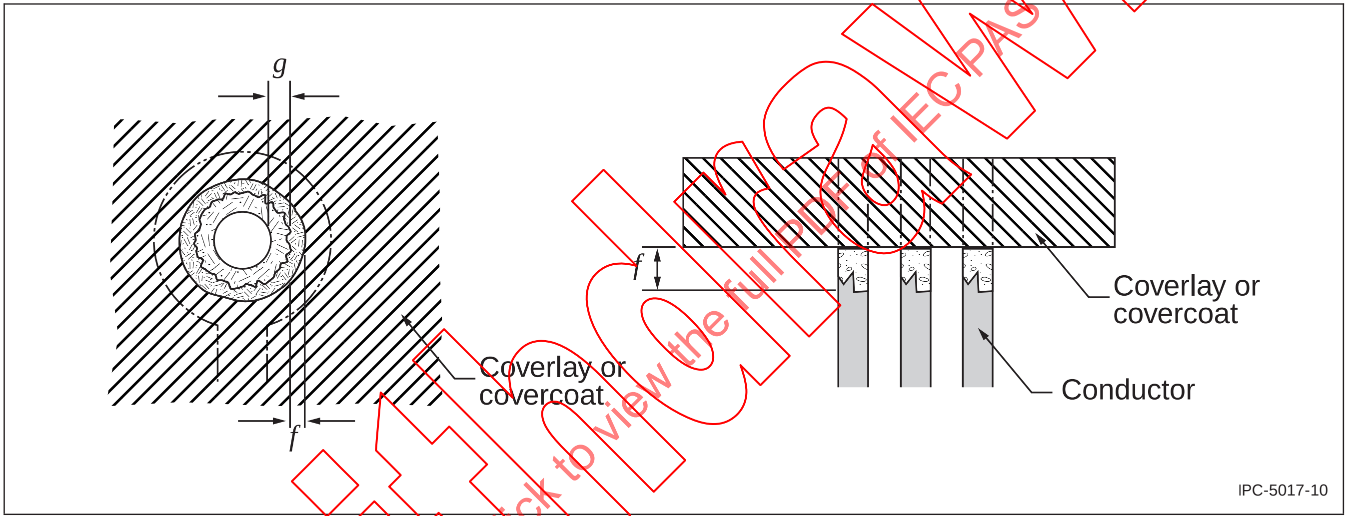

Figure 10 Adhesive Flow and Covercoat Blur

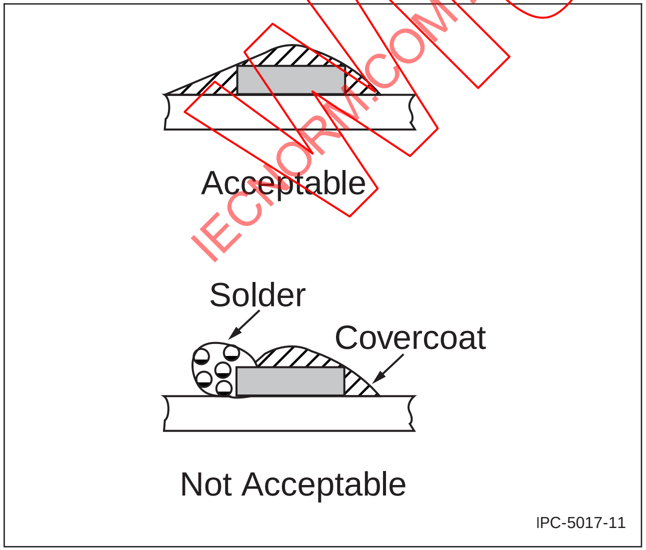

Figure 11 Covercoat Blur

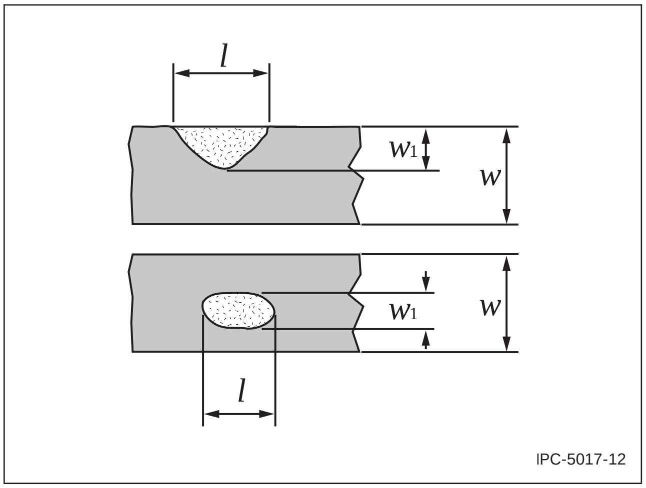

Figure 12 Imperfection of Plating

Table 6 Width and Length of Plating Imperfection

Classification		Conductor Width after Finishing		
		(*w*)	$w < 0.30 \leq w \leq 0.45$	$0.45 < w$
Terminal Part	Width of imperfection (w_1)	Shall not exceed 1/2 of finished width (*w*).	Shall not exceed 0.15.	Shall not exceed of 1/3 finished width (*w*).
	Length of imperfection (*l*)	Shall not exceed conductor width (*w*).		
Land part		The area of imperfect plating shall be <10% of the plated area (adhesive flow is not included).		

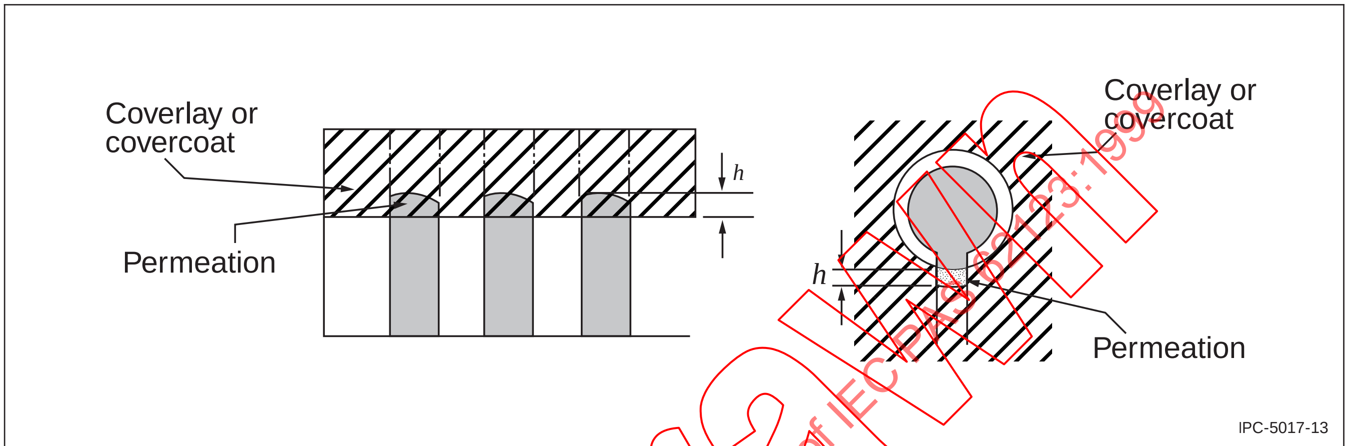

Figure 13 Permeation of Plated Metal or Solder

5.5 Symbol Mark The symbol mark shall be legible.

5.6 Defect on Appearance Due to Bonding of Reinforcing Material

5.6.1 Positional Discrepancy of Reinforcing Material

5.6.1.1 Misalignment of Holes The misalignment (*l*) of a hole on reinforcing material and a hole on the flexible printed board, as illustrated in Figure 14, shall be such that the hole diameter on the flexible printed board or that on the reinforcing material, whichever is the smaller, does not decrease by 0.3 mm or more. Provided D-*l* shall fall within the tolerance on D.

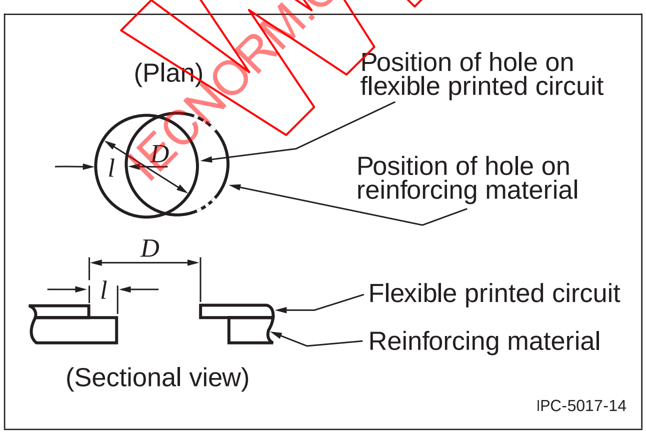

Figure 14 Misalignment of Holes

5.6.1.2 Discrepancy of Outlines The discrepancy of outlines (*j*), as illustrated in Figure 15, shall not be >0.5 mm.

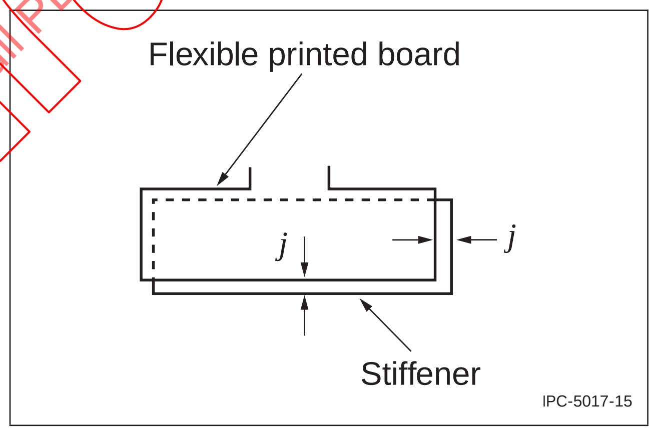

Figure 15 Discrepancy of Outlines

5.6.2 Slip of Pressure Sensitive Adhesive or Adhesive (Including Flow) Between Board and Reinforcing Material The slip (*k*) of pressure sensitive adhesive or adhesive between the flexible printed board and reinforcing material (including the flow), as illustrated in Figure 16, shall not be > ± 0.5 mm. The tolerance on the component hole diameter shall be satisfied.

5.6.3 Foreign Substance Between Board and Reinforcing Material The foreign substance between the board and reinforcing material, as illustrated in Figure 17, shall be such that the swell (*m*) is not > 0.1 mm. If the thickness of the reinforcing material and flexible printed board are specified, the swell shall fall within the tolerance of the said thickness.

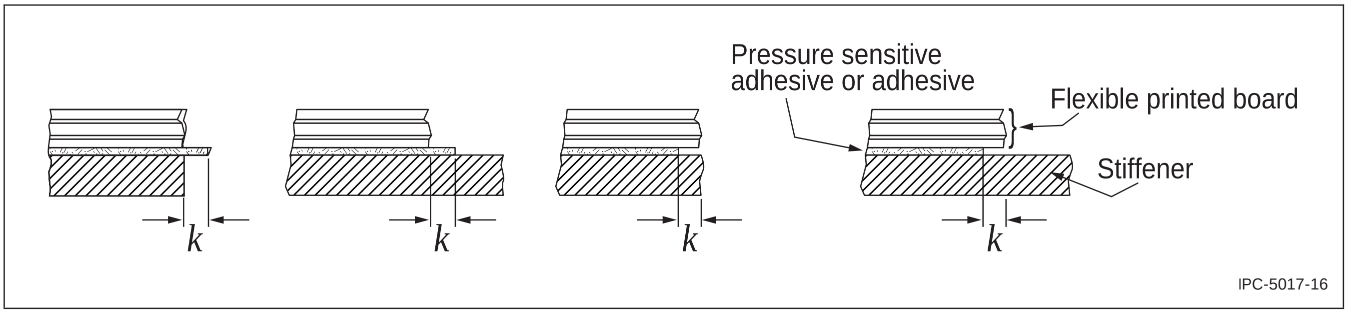

Figure 16 Slip of Pressure Sensitive Adhesive or Adhesive Between Board and Reinforcing Material (Including Flow)

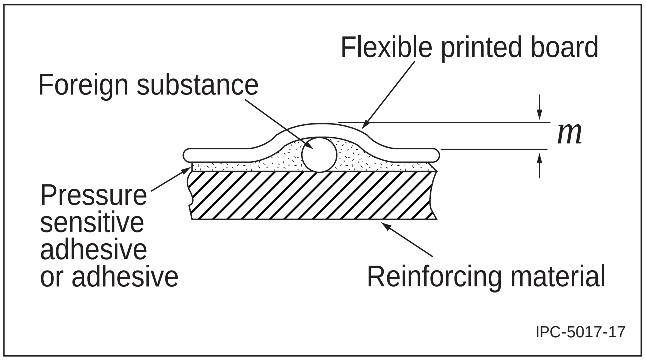

Figure 17 Foreign Substance Between Board and Reinforcing Material

The size of foreign substances shall not exceed 5% of the adhering area of the reinforcing material and flexible printed board, and substances that come in contact with drilled holes or outline edges are not allowed.

5.6.4 Bubbles Between Board and Reinforcing Material Bubbles between the board and reinforcing material, as illustrated in Figure 18, shall be such that the bubbled area shall not exceed 10 % of the reinforcing material area when thermosetting adhesive is used, and not more than 1/3 of the reinforcing material area when other adhesive is used. There shall be no raise or blistering in the end of the connector inserting part.

Further, blistering shall not appear at the mounting.

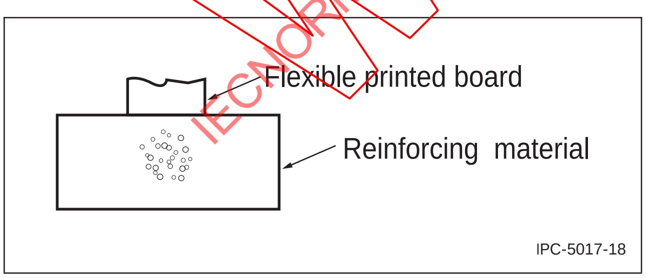

Figure 18 Bubble Between Board and Reinforcing Material

5.7 Other Appearances

5.7.1 Filiform Burr

5.7.1.1 Hole Part The length of non-conductive filiform burrs in the hole part, as illustrated in Figure 19, shall not be >0.3 mm. The burr shall not fall down easily.

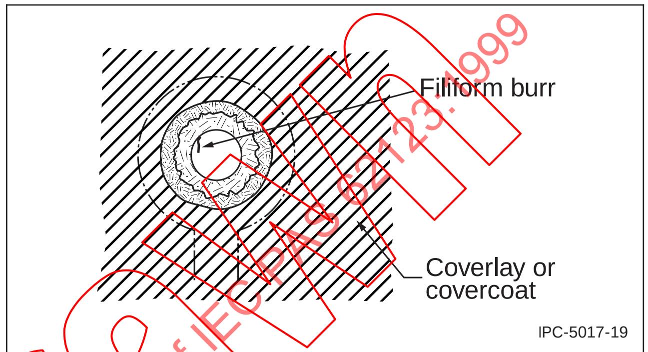

Figure 19 Filiform Burr in Hole Part

5.7.1.2 Outline The length of non-conductive filiform burrs on the visual outline, as illustrated in Figure 20, shall not be >1 mm. The burr shall not fall down easily.

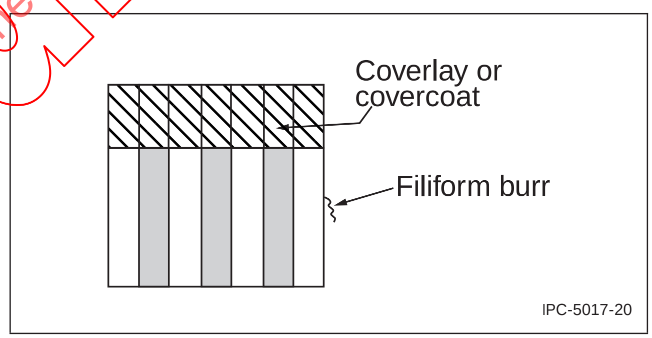

Figure 20 Filiform Burr on Visual Outline

5.7.2 Deviation of Outline Punching As for the deviation of outline punching illustrated in Figure 21, if the outline is in contact with the pattern, the product shall be considered defective. The plated leads, independent land for reinforcement, and patterns for reinforcement are excluded.

5.7.3 Substances Adhering on the Surface Substances adhering on the board surface shall be as stated in 5.7.3.1 through 5.7.3.5.

5.7.3.1 Substances that easily fall away are allowed.

5.7.3.2 Cured adhesive, coverlay with adhesive, and fiber with adhesive that are firmly fixed to such an extent they do not fall away when rubbed by a swab soaked with isopropyl alcohol are allowed. However, the portion for which the thickness is specified is excluded.

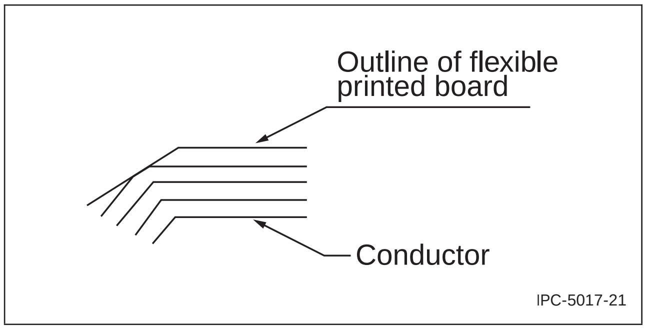

Figure 21 Deviation of Outline Punching

5.7.3.3 Residual Flux If the swab does not become dirty when the residual flux is rubbed with a swab soaked with isopropyl alcohol, such residual is allowed.

5.7.3.4 Solder Particle Solder particles that fall away easily are allowed (particles that fall away within one minute by ultrasonic cleaning).

Permissible size and number of firmly fixed particles are as follows:

$0.10 \text{ mm} \leq \phi < 0.30$ mm up to three particles

$0.05 \text{ mm} \leq \phi < 0.10$ mm up to 10 particles

5.7.3.5 Pressure Sensitive Adhesive Chips Permissible size and number of pressure sensitive adhesive chips are as follows:

$1.0 \text{ mm} \leq \phi$ $0.1 \text{ mm} \leq \phi$

6 Marking, Packaging, and Storage

6.1 Product Marking The following information shall be marked on each product:

(1) Type designation or serial number

(2) Manufacturer's name or abbreviation

6.2 Package Marking The following information shall be marked on each package:

(1) Kind (mark the symbol denoting flexible printed board on an easily visual position)

(2) Type designation or serial number

(3) Packed quantity

(4) Year and month of manufacture

(5) Manufacturer's name or abbreviation

6.3 Packaging and Storage

6.3.1 Packaging In the packaging, adequate measures to avoid moisture and product damage shall be taken.

6.3.2 Storage The flexible printed boards shall be stored in a place where adequate measures to avoid moisture are taken.

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JIS C 5603-1993
Terms and Definitions for Printed Circuits

1 SCOPE

This Japanese Industrial Standard specifies the terms related to printed circuits used mainly for the electronic apparatus (hereafter referred to as ''terms'').

Remarks: The International Standard corresponding to this Standard is given below.

IEC 194 (1988) Terms and Definitions for Printed Circuits

2 Classification

The terms are defined according to the following classification:

(1) General

(2) Base material

(3) Conception - Artwork master

(4) Manufacturing

(5) Testing - Inspection

3 TERMS AND DEFINITIONS

Terms and definitions are as stated below:

The English equivalents are shown as informative references.

Remarks:

1. When the term is in the long form, it is written in two lines. In this case, the first letter in the second line starts from the position of the second letter in the first line.
2. When two or more terms are written together in a section of terms, their priority of use shall be given in the written order.

   When the first term is especially recommended, the second term is written in parentheses "( )".
3. When a part of a term is in square brackets "[ ]", it may be used in two ways (i.e., one is including the part put in the brackets and the other is excluding it).
4. When limiting the scope of use, it is shown in the square brackets "[ ]" following the term.

(1) GENERAL

101 Printed Circuit Circuit consisting of printed wiring, printed components, and/or attached parts.

102 Printed Wiring Wiring or its technique, in which the conductive pattern is formed on the surface of the base material, or on the surface and inside of it, by means of printing for the connection between parts, based on the circuit design.

Remarks: The forming technique of the printed component is not included.

103 Printed Circuit Board (PCB) Board forming the printed circuit.

Remarks: It is also called printed circuit assembly (PCA).

104 Printed Wiring Board (PWB) Board forming the printed wiring.

105 Printed Board Abbreviation of printed wiring board (PWB).

106 Rigid Printed Board Printed wiring board (PWB) using a rigid base material.

107 Flexible Printed Wiring Board Printed wiring board (PWB) using a flexible base material.

108 Flex-Rigid Printed Wiring Board Printed wiring board (PWB) consisting of a flexible printed wiring board (PWB) and rigid printed wiring board (PWB).

109 Single-Sided Printed Wiring Board Printed wiring board (PWB) on one side surface of which the conductive pattern is formed.

110 Double-Sided Printed Wiring Board Printed wiring board (PWB) on both side surfaces of which the conductive patterns are formed.

111 Multilayer Printed Wiring Board Printed wiring board (PWB) in which the conductive patterns are formed on three or more layers, including the surface conductive layer.

112 Single-Sided Flexible Printed Wiring-Board Flexible printed wiring board (PWB) on one side surface of which the conductive pattern is formed.

113 Double-Sided Flexible Printed Wiring Board Flexible printed wiring board (PWB) on both side surfaces of which the conductive patters are formed.

114 Multilayer Flexible Printed Wiring Board Flexible printed wiring board (PWB) in which the conductive patterns are formed on three or more layers, including the surface conductive layer.

115 Metal Core Printed Wiring Board Printed wiring board (PWB) using a metal core base material.

116 Mother Board Printed wiring board (PWB) prepared for the mounting and connection of plural printed circuit boards (PCBs).

Remarks: Boards referred to as ''back panel'' or ''back plane'' are included.

117 Component Side The side of the printed wiring board (PWB) for mounting components on which most of components will be mounted.

118 Solder Side The side of a printed wiring board (PWB) opposite the component side, and on which the most soldering will be made.

119 Grid An imaginary network or coordinate system consisting of two sets of parallel equidistant lines intersecting at a right angle, for positioning connections on a printed wiring board (PWB).

120 Printing Act of reproducing a pattern on a surface by any process.

121 Pattern Configuration of conductive and/or non-conductive patterns formed on the printed wiring board (PWB).

Remarks: It is also used for the configuration on the board, drawing, and film to be used.

122 Conductive Pattern Configuration formed by electrically conductive material of a printed wiring board (PWB).

123 Non-Conductive Pattern Configuration formed by functional non-conductive material of a printed wiring board (PWB).

124 Conductor Single conductive path in a conductive pattern.

125 Flush Conductor Conductor of which the outer surface is in the same plane as the surface of the base material

126 Printed Contact Portion of a conductive pattern serving as one part of a contact system.

127 Edge Board Contact Series of contacts printed on the edges of a printed wiring board (PWB).

Remarks: They are usually mated with an edge socket connector.

128 Printed Component Electronic component formed by means of a printing technique (e.g., printed inductor, register, capacitor or transmission line).

129 Taped-Components Components previously attached to continuous tape to make their automatic attachment and automatic inspection easy.

130 Solder Paste Mixture of solder powder and flux in paste form.

Remarks: It is also called cream solder or solder paste.

(2) BASE MATERIAL

201 Base Material Insulating material upon which the pattern may be formed.

Remarks:

1. The material may be rigid or flexible.
2. Generic name for ones with metal foil and without metal foil.

202 Prepreg Sheet material (i.e., glass fabric) impregnated with a resin cured to a B stage.

203 B-stage Resin A thermosetting resin in an intermediate stage of curing reaction.

204 Bonding Sheet Sheet made of the material having suitable adhesive properties and used to bond together individual layers to produce a multilayer printed wiring board (PWB).

Remarks: For example, prepreg, bonding film, etc.

205 Wicking Capillary absorption of liquid along the fibers of the base material.

206 Metal-Clad Base Material Base material covered with metal on one or both sides being used for printed wiring boards (PWBs).

207 Copper-Clad Laminate Laminate covered with copper foil on one or both sides being used for printed wiring boards (PWBs).

208 Base Film Film that is the base material for the flexible printed wiring board (PWB) and on the surface of which the conductive pattern can be formed.

Remarks: When the heat resistance is required, polyimide film is mostly used, and when the heat resistance is not required, polyester film is usually used.

209 Conductive Foil Conductive material that covers one or both sides of the base material and is intended to form the conductive pattern.

210 Copper Foil Conductive foil that covers one or both sides of the base material in which copper is used for forming the conductive pattern.

211 Lamination To bond two or more layers making materials to one entity.

212 Laminate Base material made by laminating and bonding glass cloth, paper, etc., impregnated with resin.

213 Metal Core Base Material Base material having a metal sheet as the support for the printed wiring board (PWB). It is sometimes used as the layer for heat sink or power supply grounding.

214 Conductive Paste Conductive material for forming conductive patterns and through holes by printing on one or both sides of the base material.

Remarks: There are conductive pastes based on silver, copper, nickel, carbon, etc.

215 Woven Glass Fabric (Glass Cloth) Cloth woven with yarns of glass fiber.

216 Nonwoven Glass Fabric A sheet-formed product made by entangling glass fibers.

217 Composite Laminate Laminate in which two or more kinds of prepreg employing paper, nonwoven glass fabric, woven glass fabric, etc., are alternately combined. In general, woven glass cloth and another material are combined.

(3) CONCEPTION — ARTWORK MASTER

301 Through Connection Electrical connection between conductive patterns on opposite sides of a printed wiring board (PWB).

302 Interlayer Connection Electrical connection between conductive patters in different layers of a multilayer printed wiring board (PWB).

303 Wire Through Connection A through connection using a wire in a single hole.

304 Plated-Through Hole Hole in which metal is deposited on the wall for the purpose of the through connection.

305 Plain Hole Hole penetrating from front to rear of a printed wiring board (PWB) without plating on its wall.

306 Copper Plated-Through Hole Plated-Through hole composed of the copper plating only and is not overplated.

307 Tin/Lead Plated-Through Hole Plated-through hole overplated using solder.

308 Conductive Paste Coated-Through Hole Through hole connected with conductive paste.

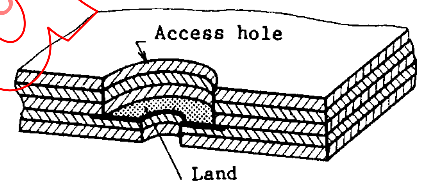
309 Landless Plated-Through Hole Plated-through hole without land.

310 Land Portion of a conductive pattern used for the connection and/or attachment of components. Pad and component mounting hole for surface mounting, conductive pattern surrounding a via, etc., are included.

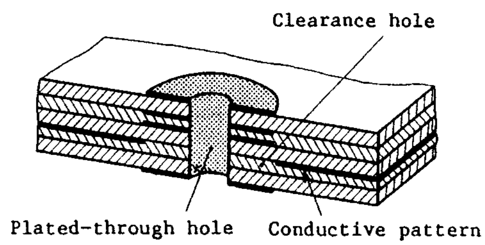
311 Pad Land on which surface-mounting component is placed.

312 Footprint Group of pads on which a surface-mounting multi-terminal component is placed.

313 Access Hole Hole that provides access to the surface of the land in one of the layers of a multilayer printed wiring board (PWB).



314 Clearance Hole Area without conductive material, in a conductive pattern around a plated through hole of a multilayer printed wiring board (PWB), in order to prevent any electrical connection to the plated-through hole.



315 Tooling Hole (Location Hole) Hole provided on the printed wiring board (PWB) or panel to carry out accurate positioning. It is used for manufacturing, mounting of components, inspection, etc., of printed wiring boards (PWBs).

316 Location Notch Notch provided on the printed wiring board (PWB) or panel to carry out accurate positioning. It is used for manufacturing, mounting of components, Inspection, etc. of printed wiring board.

317 Mounting Hole Hole used for the mechanical mounting of a printed wiring board (PWB) or for mechanical attachment of components to the printed wiring board (PWB).

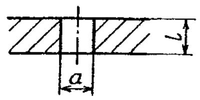
318 Component Hole Hole used for the attachment of component terminations to the printed wiring board (PWB), as well as for any electrical connection to the conductive pattern.

319 Via Hole used for connection between layers only. It is not used for mounting of components.

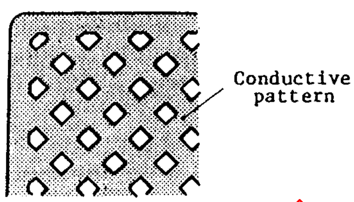
320 Hole Pattern Arrangement of all holes in a printed wiring board (PWB).

321 Aspect Ratio Quotient of thickness of the printed wiring board (PWB) and hole diameter before plating.

Aspect ratio = $\frac{t}{a}$



322 Cross-Hatching Deliberate subdividing of large conductive areas by setting up the portion without a conductor.



323 Polarizing Slot Slot in the edge of a printed wiring board (PWB) used to assure proper insertion and correct location in a mating connector.

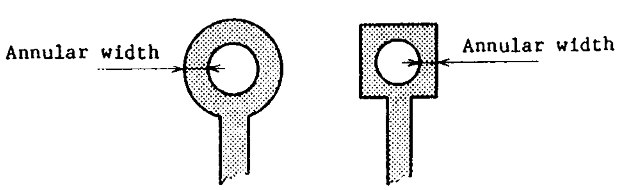
324 Datum Reference A defined point, line, or plane used to locate patterns, holes, or layers.

325 Layer-to-Layer Registration, Layer Registration Arrangement of mutual location of patterns in individual layers in the printed wiring board (PWB).

Remarks: Location hole, location mark, and the like are usually used for this purpose.

326 Annular Width Width of the annular part of the land surrounding the hole.

Remarks: Minimum annular width is usually specified.



327 Layer Generic term of various kinds of layers that make up the printed wiring board (PWB).

Remarks: They are called conductor layer, insulation layer, etc., in terms of function and internal layer, external layer, coverlayer, and so on in terms of construction.

328 Conductor Layer Conductive layers, namely signal plane, power source plane, ground plane, etc.

329 Signal Plane Conductor layer intended to transmit the electrical signal.

Remarks: Layers grounded or loaded with certain voltage are not called signal plane.

330 Voltage Plane Conductor layer mainly intended to supply voltage plane the power.

331 Ground Plane Conductor layer used on the surface or in the inner part of the printed wiring board (PWB) for the purpose of connection with the ground, power supply, shield, or heat sink.

332 Insulating Layer Non-conductive layer.

333 Internal Layer Internal conductive pattern layer in a multilayer printed wiring board (PWB).

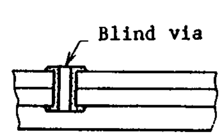
334 External Layer Surface conductive pattern layer in a multilayer printed wiring board (PWB).

335 Layer-to-Layer Spacing Thickness of the insulation material put between adjacent conductor layers in a multilayer printed wiring board (PWB).

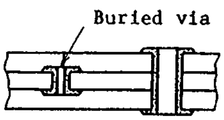
336 Coverlayer Insulation layer covering the surface of a printed wiring board (PWB), including the conductive pattern.

337 Conformal Coating Insulating protective coating, which configuratively covers the surface of a completed printed circuit board (PCB).

338 Blind Via Via that connects the conductive pattern of an external layer with the conductive pattern of an internal layer in a multilayer printed wiring board (PWB), which has an opening on one side (front or rear) of the PWB and does not pass from the front to the rear (see following figure).



339 Buried Via Via that is buried in the interior of a printed wiring board (PWB) for connection between internal layers and which has no opening on the surface of the PWB.



340 Legend (Symbol Mark) Letters, numbers, symbols, locations of parts, and shapes indicated on the printed wiring board (PWB) for the convenience of assembly and repair.

341 Jumper A conductive pattern separately formed afterward to provide connection between two points on a printed wiring board (PWB) by wire, conductive paste, etc.

342 Register Mark Mark that is used as the reference for carrying out registration.

(4) MANUFACTURING

401 Photographic Reduction Dimension Reduced and finished dimension on the artwork master to indicate the extent to which the artwork master is to be photographically reduced.

402 Positive Pattern Pattern on a film in which the conductive part is non-transparent.

403 Negative Pattern Pattern on a film in which the conductive part is transparent.

404 Artwork Master Original drawing of a specified magnification to be used for manufacturing the original production master.

405 Original Production Master A 1:1 scale pattern which is used to produce original production master.

Remarks: the production master, which is either negative or positive, is in the form of film or dry-plate.

406 Production Master Film or dry-plate that has a 1:1 scale pattern and is used in the production of printed wiring boards (PWBs).

407 Multiple Image Production Master Film or dry-plate that has at least two 1:1 scale patterns and is used in the production of printed wiring boards (PWBs).

408 Panel The work piece of the size fitting the manufacturing facilities that passes through the production sequence of the printed wiring board (PWB).

409 Multiple Pattern Pattern in which two or more patterns are arranged within the size of one panel.

410 Multiple Printed Panel Panel printed by means of multiple image production masters.

411 V-Grooving Groove in the V form made for the division of the panel or printed wiring board after mounting.

412 Subtractive Process Process for obtaining conductive patterns by selective removal (i.e., by etching) of the unwanted portions of the conductive foil on metal-clad base material.

413 Additive Process Process for obtaining conductive patterns by the selective deposition of conductive material on unclad base material.

414 Fully-Additive Process One of the additive processes, which uses the electroless deposition only.

415 Semi-Additive Process One of the additive processes for obtaining conductive patterns by a combination of electroless metal deposition with electroplating and/or etching.

416 Die Stamping Process for making printed wiring boards (PWBs) in which conductive patterns stamped out of the metal plate are stitched to the base metal.

417 Build-Up Process Process for making multilayer printed wiring build-up process boards by gradually building up the conductor layers and insulation layers by means of plating, printing, etc.

418 Sequential Laminating Process Process for making multilayer printed wiring sequential boards in which plural double-sided printed wiring boards (PWBs), having conjunction holes for connecting the conductive patterns on both sides, are laminated or combined with the single-sided PWB, and if necessary, connections between all conductive layers are made by the plated-through holes.

419 Hole Plugging Process Process for making the printed wiring board (PWB) with copper plated-through holes in such a way that the hole is plugged with filler after the through-hole plating, the positive pattern of conductor is formed on the surface being followed by etching, then the filler and the resist on the surface are removed.

420 Roll-to-Roll Process One of the processes for making flexible printed wiring boards (PWBs) to carry out continuously a part or of the entire manufacturing process in a roll.

421 Pin Lamination Manufacturing technique for multilayer printed wiring boards (PWBs) in which the conductive pattern on each layer is positioned by means of guide pins and the laminates are made to one laminated body.

422 Mass Lamination Mass production technique for multilayer printed wiring boards (PWBs) in which many boards are laminated at the same time in such a way that upper and lower faces of the internal panel having the conductive patterns made in advance are placed between each of the prepreg and the copper foil layers, respectively.

423 Resist Coating material used to mask or protect a selected area against etchant, plating liquid, or soldering during manufacturing or testing.

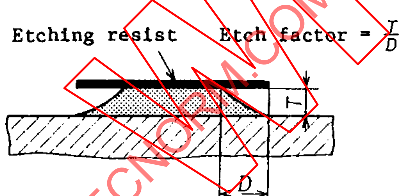
424 Solder Resist A heat-resisting coating material applied to selected areas on a printed board to prevent the deposition of solder upon those areas during subsequent soldering operations.

425 Etching Chemical or electrochemical removal of the unwanted part of a conductor on the base material when making the conductive pattern.

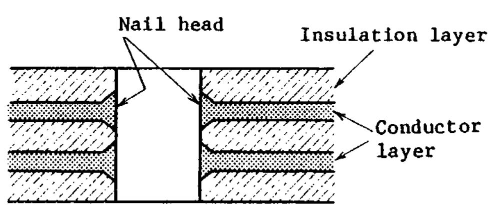
426 Etchant Corrosive solvent used for etching.

427 Differential Etching Etching to leave the wanted conductive patterns by making the thickness of the conductive layer thinner in the unwanted conductive area than in the wanted conductive area. (The thickness of wanted conductive area is also reduced by the etching.)

428 Etch Factor Ratio of depth (T) of etch in the direction of the conductor thickness to depth (D) of the lateral etch.



429 Nail Heading Flared condition of copper on the inner conductor layers of a multilayer printed board caused when drilling.



430 Etch Back Controlled removal of base material on the side walls of holes to a specific extent in order to remove smear and further increase the exposed surface area of internal layer conductor.

431 Push Back Process to push back the punched product to the original position in the punching process of products.

432 Desmear Treatment to clean the smear on conductor surface in a hole by a chemical or other process.

Remarks: A chemical process or plasma process is usually used.

433 Through Hole Plating Metal plating on the side wall of a hole or the plated metal itself for the purpose of through connection.

434 Panel Plating Plating of the entire surface of a panel (including through hole).

435 Pattern Plating Selective plating of a conductive pattern.

436 Tenting Etching by covering the plated-through hole and the conductive pattern surrounding it with resist.

Remarks: Usually, a dry film is used for resist.

437 Overplating Plating over the conductive pattern formed previously, or a part of it.

438 Photoresist Resist, the light-irradiated part of which becomes soluble or insoluble to the liquid developer.

Remarks: Resist that becomes insoluble is called “negative type” and one that becomes soluble is called “positive type”.

439 Plating Resist Resist used for a part for which plating is unwanted.

440 Etching Resist Etching resistance coating to be applied to the part where etching is not wanted.

441 Coverlay Film covering the conductive portion of a flexible printed wiring board (PWB) for insulation protection.

Remarks: Film has been removed from the conductive part necessary for connection, such as land and terminal.

442 Covercoat Insulation coating covering the conductive part of the flexible printed wiring board for insulation protection.

Remarks: Conductive parts, such as lands and terminals, are not coated.

443 Screen Printing A process for transferring an image on a surface by forcing suitable media through a stencil screen with a squeegee.

444 Fusing Melting of the metal coating on a conductive pattern followed by solidification.

Remarks: Metal coating is usually the result of solder plating.

445 Hot Air Leveling Process to make the surface smooth by removing the excess solder after dipping into the molten solder using hot air.

446 Solder Leveling Redistribution and/or partial removal of the molten solder (independent from method and composition of solder) from a printed wiring board (PWB) by applying sufficient heat and mechanical force.

Remarks: Heating and mechanical force may be supplied by the same medium, such as a jet stream of heated oil or hot air. This is also called ''solder coating.''

447 Dip Soldering Method of simultaneously soldering all exposed conductive patterns and component terminals by bringing the printed wiring board (PWB) on which the components are mounted in contact with the still surface of the molten solder bath.

448 Flow Soldering, Wave Soldering Method of soldering by bringing a printed wiring board (PWB) in contact with the surface of the solder, which is continuously flowing and circulating.

449 Vapor Phase Soldering (Condensation Soldering) Reflow soldering technique where the solder is fused by the heat energy released when the vapor of a liquid having a high enough boiling point at which the intended solder melts condensed.

450 Reflow Soldering The making of a solder joint by melting of solder coatings already applied.

Remarks: ''Solder coatings already applied'' means solder plating, solder paste, etc.

451 Surface Mounting Electrical connection of components on the mounting surface of a conductive pattern without utilizing component holes.

Remarks: ''Surface mounting technique'' is sometimes abbreviated as SMT.

452 Wetting Condition of a metal surface on which solder is coated uniformly, continuously, and smoothly.

453 Dewetting Formations of very thin solder due to retraction of solder initially wetting the metal surface.

454 Non-wetting Such a condition where the solder does not deposit on the entire metal surface, resulting in the base metal being partially exposed.

455 Manufacturing Drawing Drawing that specifies specifications and characteristics (e.g., shape, pattern, and its arrangement, hole, slot, finish, etc.).

456 Plating Process consisting of chemical or electrochemical deposition of metal on a component to be processed (e.g., base material, through hole, conductive pattern, etc.).

Remarks: In a broad meaning, such dry metal coatings as metallizing, spattering, ion coating, thermal spraying, and solder covering are included other than the above wet metal coating.

457 Electroless Plating A deposited metal surface treatment where the metal is deposited by chemical reduction on a metallic or non-metallic surface without the use of an electric current (also known as chemical plating).

458 Plating Bar Temporary conductive path interconnecting areas of a printed wiring board (PWB) to be electroplated.

459 Fillet Shape of solder when a component lead is soldered with the land.

460 Dry Film Resist Photosensitive resist previously made in a film.

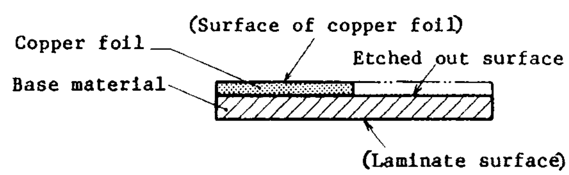
461 Perforation Holes continuously provided (like seam by sewing machine) on a printed wiring board (PWB) to allow division of the board after completion of mounting and soldering of components.

Remarks: This is used for the same purpose as that of a V-cut.

462 Permanent Resist Resist not removed after processing (e.g., plating resist in fully additive process).

(5) TESTING-INSPECTION

501 Copper Side Side adhered by copper foil on single-sided copper-clad laminate or single-sided printed wiring board (PWB).



502 Etched-Out Surface Surface of the base material where copper foil is removed away.

503 Base Material Side Side on which no copper foil is pasted, in a single-sided copper-clad laminate or single-sided printed wiring board (PWB).

504 Base Film Side Side of a single-sided flexible printed wiring board (PWB) on which the conductive pattern is not formed.

505 Adhesive-Coated Surface Cloth surface on which the adhesive is coated before plating, in the case of fully-additive process, and the etched out surface of copper-clad laminate using adhesive, in the case of subtractive process.

506 Test board A printed wiring board (PWB) suitable for determining the acceptability of the board or of a batch of boards produced with the same process so as to be representative of the production board.

507 Test Coupon A portion of a printed wiring board (PWB) used to determine the acceptability of the board.

Remarks: It is usually prepared on the same panel with the products and used separately.

508 Test Pattern Pattern used for the purpose of test and/or inspection.

509 Composite Test Pattern Combination of two or more test patterns.

510 Microsectioning To prepare the specimen by cutting the board for the purpose of observation of the interior of a printed wiring board (PWB) by means of a microscope.

511 Sliver Thin metallic protrusion that is about to be detached from the end of conductor.

512 Resin Smear Resin transfer from the base material onto the surface or edge of the conductive pattern at the time of drilling and the like.

Remarks: It usually occurs at drilling work.

513 Bow Deviation from flatness of a board characterized by a roughly cylindrical or spherical curvature such that, if the board is rectangular, its four corners are in the same plane.

514 Twist Deformation of a rectangular sheet, such that one of the corners is not in the plane containing the other three corners.

515 Board Thickness Thickness of the metal-clad base material or printed wiring board (PWB) including the conductive layer or layers but excluding additional platings.

516 Total Board Thickness Overall thickness of a printed wiring board (PWB) after its finish.

517 Base Material Thickness The thickness of the base material excluding conductive foil or material deposited on the surfaces (solder resist or the like).

518 Registration Degree of conformity of the position of a pattern, or a portion thereof, with its intended position or with any other pattern of the printed wiring board (PWB).

519 Edge Distance The distance of a pattern and/or components from the edges of the printed wiring board (PWB).

520 Conductor Width The observable width of the conductor when a printed wiring board (PWB) is viewed vertically from above.

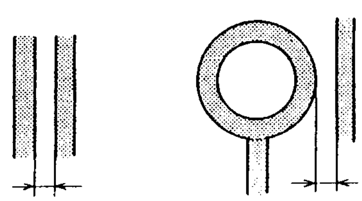
Remarks: Imperfections allowed by the relevant specification are not included.

521 Conductor Pitch Distance between the centers of adjacent conductors.

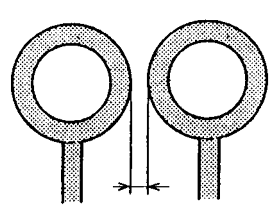
522 Design Width of Conductor The design width of a conductor specified and agreed upon between the purchaser and manufacturer.

523 Conductor Spacing Spacing between adjacent edges of conductors on a single layer of the printed wiring board (PWB), viewed from just over.

Remarks: This does not mean the distance between the centers of two conductors (see the following Figures).

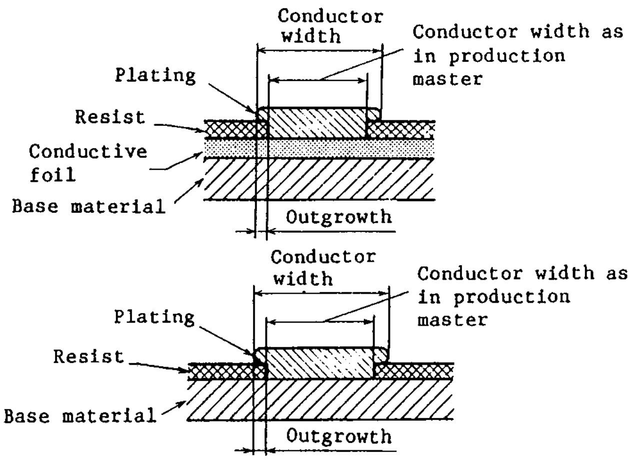


524 Land Spacing Conductor spacing between adjacent lands (see the following Figures).

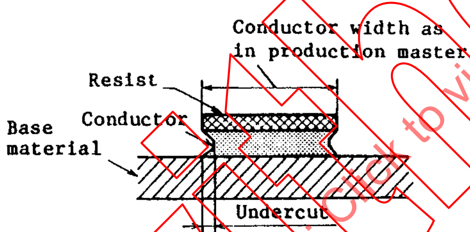


525 Conductor Thickness Conductor thickness, including additional adhering metal.

526 Outgrowth Increase in conductor width at one side of a conductor, caused by plating build-up, over that given in the production master or by the resist.

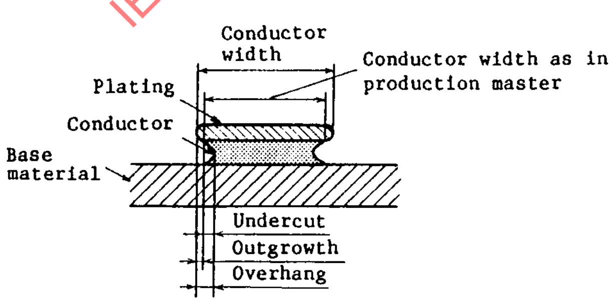


527 Undercut Groove or excavation at one edge of a conductor caused by etching.



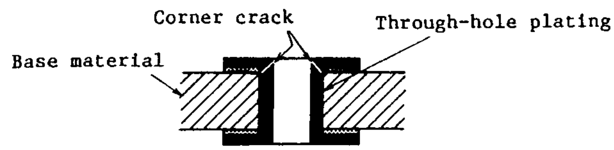
528 Overhang Sum of outgrowth and undercut.

Remarks: If undercut does not occur, the overhang is the outgrowth only.

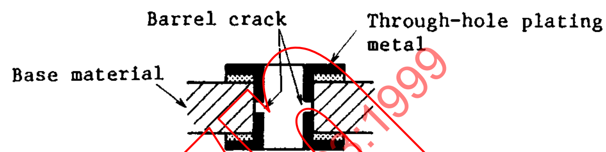


529 Void Lack of deposition of a substance in a void localized area.

530 Corner Crack Crack of plated metal at the corner of through hole.



531 Barrel Crack Crack of plated metal on the internal wall barrel crack of through hole.



532 Delamination Total or partial separation of ply within base material or multilayer printed wiring boards (PWBs).

533 Blister Partial blister or separation occurring between layers of base material or between base material and conductive foil.

Remarks: Blister is one form of delamination.

534 Crazing An internal condition occurring in the base material in which the glass fibers are separated from the resin at the weave intersections, usually related to mechanically induced stress.

Remarks: This condition manifests itself by connected white spots or crosses below the surface of the base material.

535 Measling An internal condition occurring in the base material in which the glass fibers are separated from the resin at the weave intersection, usually related to thermally-induced stress.

Remarks: This condition manifests itself in the form of discrete white spots or crosses below the surface of the base material.

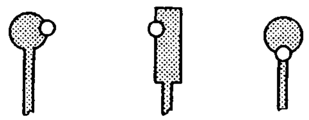
536 Mealing White granular spots that occur between the printed wiring board (PWB) and conformal coating.

537 Blow Hole Void or plated-through hole with void caused by outgassing when soldering the hole.

538 Outgassing Emission of gas or vapor from a printed wiring board (PWB) when this is exposed reduced air pressure or heat or both.

539 Haloing Mechanically or chemically-induced fracturing or delaminating on or below the surface of the base material, usually exhibited by a light area around holes and/or machined areas.

540 Hole Breakout Condition in which a hole is not completely surrounded by the land as a result of deviation of hole location.



541 Treatment Transfer Traces of the conductive foil left on the treatment transfer base material surface after removal.

Remarks: It usually occurs in the form of black, brown, or red streaks.

542 Weave Texture Surface condition where the texture of glass cloth is seen clearly, even though the fiber of glass cloth in the base material is completely covered by resin.

543 Weave Exposure Surface condition where the fiber of glass cloth in the base material is not completely covered by resin.

544 Flaming Burning condition with flame.

545 Glowing Red heating condition without flame.

546 Bump Protuberance of conductor formed for the purpose of connection on a component mounting pattern of a printed wiring board (PWB) (pattern called out as footprint, or pad) or a lead of a component.

547 Current-Carrying Capacity Maximum current that can be continuously carried through a conductor under specified conditions without spoiling electrical and mechanical performances of a printed wiring board (PWB).

548 Edge Definition Coincidence of the edge of pattern formed on a printed wiring board (PWB) with the production master.

549 Inclusion Foreign particle unwillingly mixed in the conductive layer and/or base material.

550 Dent (Indentation) Depression in the conductive layer that does not penetrate entirely through it.

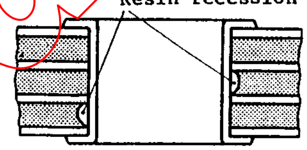
551 Pin-Hole Minute hole unwillingly penetrating through the conductive layer and/or insulating layer.

552 Pull-Out Strength Force, normal to the printed wiring board (PWB), required to separate the metallic wall of a landless plated-through hole from the base material.

553 Pull-Off Strength Force, normal to the printed wiring board (PWB), required to separate the land from the base material.

554 Peel-Strength Force per unit width required to peel the conductor from the base material.

555 Resin Recession Existence of a void between the barrel of a plated-through hole and the hole wall, which is observed on the cross section of the plated-through hole of a printed wiring board (PWB) exposed to a high temperature.



556 Metal Migration Transfer of a metal ion along a conductive path from a metal to the other metal when a voltage is being applied across two metals.

Remarks: There are two cases (i.e., the metal ion transfers along the surface of insulating material and transfers through the inside of the insulating material). Progress of this phenomenon may result in deterioration of insulation and/or short circuit.

Alphabetical Index

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

1 SCOPE

This Japanese Industrial Standard specifies test methods for copper-clad laminates for flexible printed wiring boards (PWBs).

1.1 Cited Standards

1.1.1 Japanese Industrial Standards

JIS B 7507 Vernier, Dial and Digital Callipers

JIS B 7516 Metal Rules

JIS B 7536 Electrical Comparators

JIS C 0010 Environmental Testing. Part 1: General and Guidance (IEC 68-1: 1988)

JIS C 1303 High Insulation Resistance Meters

JIS C 2110 Testing Methods for Electric Strength of Solid Insulating Materials

JIS C 5012 Test Methods for Printed Wiring Boards

JIS C 5016 Test Methods for Flexible Printed Wiring Boards

JIS C 5017 Flexible Printed Wiring Boards – Single-Sided, Double-Sided

JIS C 5603 Terms and Definitions for Printed Circuits

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

JIS C 6481 Test Methods of Copper-Clad Laminates for Printed Wiring Boards

JIS K 5902 Colophonium

JIS K 8101 Ethanol (99.5)

JIS K 8540 Sodium (+) - Tartrate Dehydrate

JIS K 8839 2-Propanol

JIS P 8115 Paper and Board – Determination of Folding Endurance by MIT Tester

JIS Z 3282 Soft Solder

JIS Z 9110 Recommended Levels of Illumination

1.1.2 International Electrotechnical Commission

IEC 249-1 (1982) Base Materials for Printed Circuits. Part 1: Test Methods

IEC 326-2 Printed Boards. Part 2: Test Methods. Amendment No. 1

IEC 674-2 Specification for Plastic Films for Electrical Purposes. Part 2: Methods of Test

2 DEFINITIONS

For the purpose of this Standard, in addition to the definitions in JIS C 0010 and JIS C 5603, the definitions in 2.1 through 2.4 shall apply.

2.1 Symbols of Base Film (Film) The symbols of base film are given below:

PET: polyethylene terephthalate film
PIA: pyromellitic acid polyimide film
PIB: biphenyl tetracarbonic acid polyimide film

2.2 Symbols of Copper Foil The symbols of copper foil are given below:

E1: standard electrodeposited copper foil
E2: electrodeposited copper foil with high elongation at ordinary temperature
E3: electrodeposited copper foil with high elongation at 180°C
Rl: cold rolled copper foil (without annealing)
R2: lightly cold rolled copper foil (without annealing)
R3: annealed rolled copper foil

2.3 Machine Direction (MD) Longitudinal direction at the time of continuous manufacture of film, copper foil, or copper-clad laminate.

2.4 Transverse Direction (TD) Lateral direction at the time of continuous manufacture of film, copper foil, or copper-clad laminate; perpendicular to MD.

3 CONDITIONS FOR TESTING

3.1 Standard Test Conditions Unless otherwise specified in the detailed specification, tests excluding electrical performance tests shall be carried out under the standard atmospheric conditions for testing specified in 5.3 of JIS C

0010 (temperature: 15°C to 35°C, RH: 25% to 75%, air pressure: 86 kPa to 106 kPa). When any doubt arises on the decision made under the standard test conditions or when specially required, the conditions stated in 3.3 shall be employed.

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

3.2 Electrical Performance Test Conditions The electrical performance test conditions shall be as stated in 3.3.

3.3 Referee Test Conditions The referee test conditions shall be the standard atmospheric conditions for referee tests specified in 5.2 of JIS C 0010 (temperature: 20°C ± 2°C, RH: 60% to 70%, air pressure: 86 kPa to 106 kPa).

3.4 Illumination of Testing Area The illumination shall be 200 Ix (illuminant range 150 lx to 300 lx) or more according to JIS Z 9110.

4 SPECIMEN

4.1 Preparation of Specimen Unless otherwise specified in the detailed specification, specimens shall be cut from the end of product. If the tolerances on dimensions of the specimen are not specified, ± 5% of the specified dimension shall be taken as the tolerances.

Care shall be taken on the handling of the specimen so as not to stain the surface by oils, sweat, or other foreign substances.

4.2 Test Pattern The shapes and dimensions of test patterns shall be as given in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, and Figure 9.

The test pattern shall be dried in a thermostatic chamber at 80°C ± 5°C for approximately 30 minutes after etching.

5 PRECONDITIONING

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

6 APPEARANCE AND DIMENSION OF TESTS

6.1 Appearance

6.1.1 Device A 3X magnifying lens shall be used.

6.1.2 Specimen The size of specimens shall be as stated in 6.1.2.1 and 6.1.2.2.

6.1.2.1 Pinhole Test

(a) Product of 480 mm width: 480 mm (width as received) x 520 mm (length)

(b) Product of 240 mm width: 240 mm (width as received) x 1040 mm (length)

(c) Product of other width: width as received x length that gives an area of 0.25 M^2 at that width

6.1.2.2 Dent Test

(a) Product of 480 mm width: 480 mm (width as received) x 260 mm (length)

(b) Product of 240 mm width: 240 mm (width as received) x 520 mm (length)

(c) Product of other width: width as received x length that gives an area of 0.125 M^2 at that width

6.1.3 Test Examine the conditions of the specimen surfaces with the naked eye or by using a magnifying lens.

6.2 Dimensions

6.2.1 Thickness

6.2.1.1 Device The device shall be the electrical comparator with minimum indication of 0.1 µm, as specified in JIS B 7536.

6.2.1.2 Specimen Use the copper-clad laminate as received as the specimen.

6.2.1.3 Measurement

(a) Set the measuring force to 5 ± 1 N, carry out the measurement on three points ≥1 m apart from each other in the MD for rolled copper-clad laminates, or five points covering the whole width in TD at almost equal intervals on each of the three sheet form specimens.

(b) Take the average of all the measured values as the thickness.

6.2.2 Width

6.2.2.1 Device The device shall be the metal rules of Grade 1 specified in JIS B 7516 or equivalent.

6.2.2.2 Specimen Use the copper-clad laminate as received as the specimen.

6.2.2.3 Measurement

(a) Carry out the measurement on three points ≥1 m apart from each other in the MD for rolled copper-clad laminate, or the length in TD on each of the three sheet form specimens, to a unit of 1 mm while the specimens are held horizontally.

(b) Take the average of the measured values as the width.

6.2.3 Length

6.2.3.1 Direct Method

6.2.3.1.1 Device The device shall be as specified in 6.2.2.1.

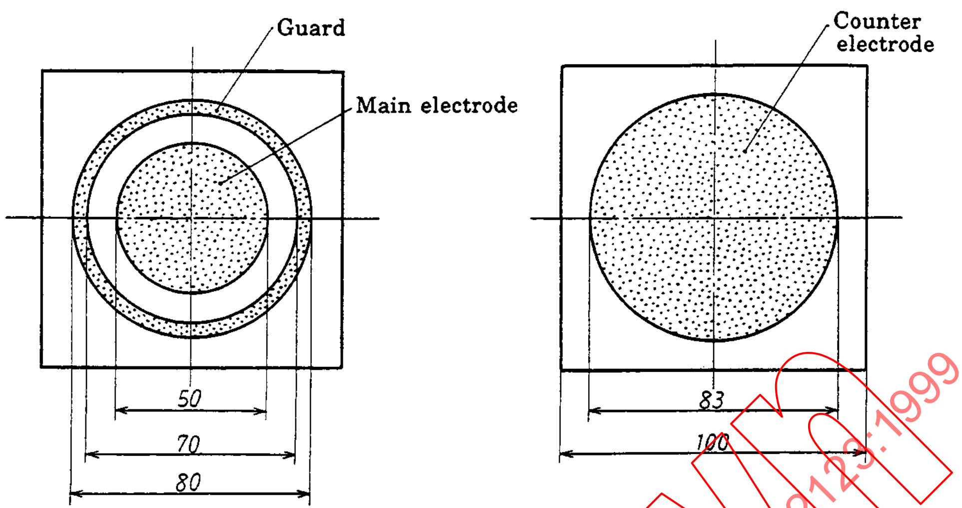


Figure 1 Specimen for Measurement of Volume Resistivity and Voltage Proof Between Layers

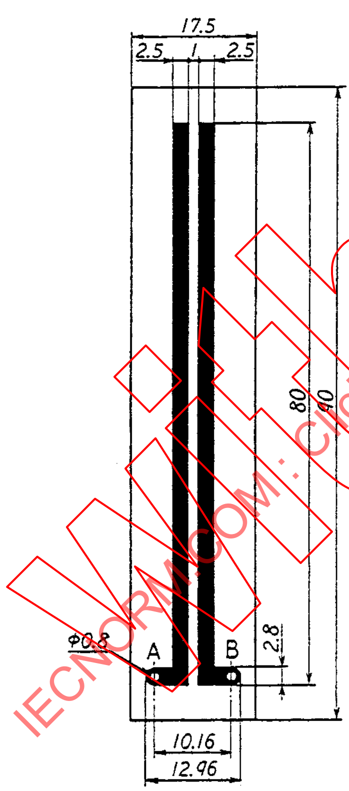


Figure 2 Specimen for Measurement of Insulation Resistance and Voltage Proof, Surface Layers

6.2.3.1.2 Specimen Use the copper-clad laminate as received as the specimen.

6.2.3.1.3 Measurement Hold the specimen horizontally by a suitable method and measure the length in MD.

6.2.3.2 Weighing Method

6.2.3.2.1 Device

(a) The metal rule specified in 6.2.2.1

(b) A balance of accuracy 0.001 g

(c) A balance that can measure the mass of one product roll.

6.2.3.2.2 Specimen Three pieces of a size 100 cm^2 ±0.5 cm^2 cut out from the three optional positions ≥1 m apart from each other in the MD of copper-clad laminate roll as received shall be used as the specimens.

6.2.3.2.3 Measurement

(a) Weigh the net mass of the roll in units of 100 g

(b) Put the specimen on the balance and weigh to the nearest 0.001 g.

(c) Calculate the length L (m) from the following formula and take the average of the calculated values as the length:

$$L = \frac{W\,x\,a}{g\,x\,B}$$

where:

W : net mass of roll (kg)
B : width of roll (mm)
g : total mass of specimens (g)
a : total area of specimens (mm^2)

7 ELECTRICAL PERFORMANCE TESTS

7.1 Volume Resistivity

7.1.1 Device The device shall be as follows:

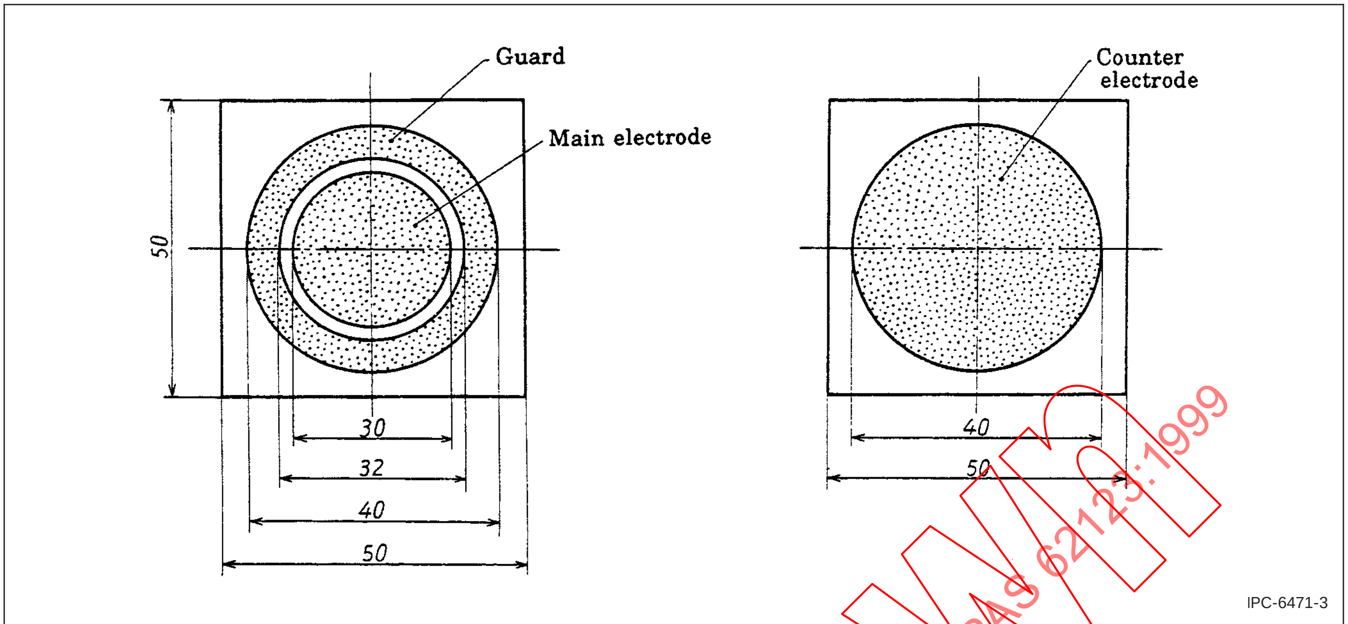


Figure 3 Specimen for Measurement of Relative Permittivity and Dissipation Factor

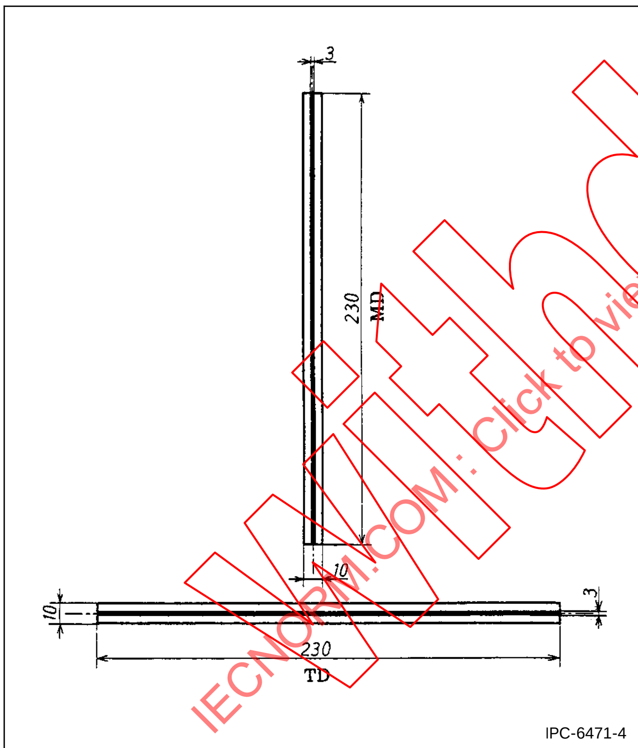


Figure 4 Specimen for Copper Foil Peel Strength Test

7.1.1.1 High insulation resistance meter specified in JIS C 1303 or a resistance-measuring device consisting of a standard resistance, universal shunt, and a galvanometer calibrated to accuracy ± 10%

7.1.1.2 Electrical comparator specified in JIS B 7536 or equivalent

7.1.1.3 Vernier caliper with minimum reading of 0.05 mm specified in JIS B 7507 or equivalent

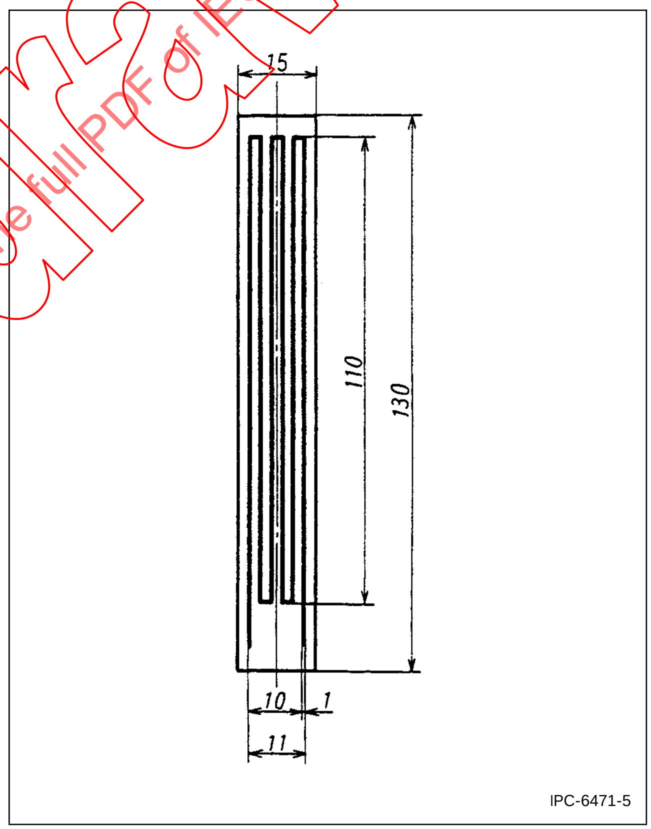


Figure 5 Specimen for Folding Resistance Test

7.1.2 Specimens Cut the sample to 100 mm^2 with the thickness as the original and prepare the electrodes shown in Figure 1 by etching.

Set the form and dimensions of the electrodes so the centers of the main, counter, and guard electrodes coincide as far as possible. However, the counter electrode is allowed to cover the whole rear surface.

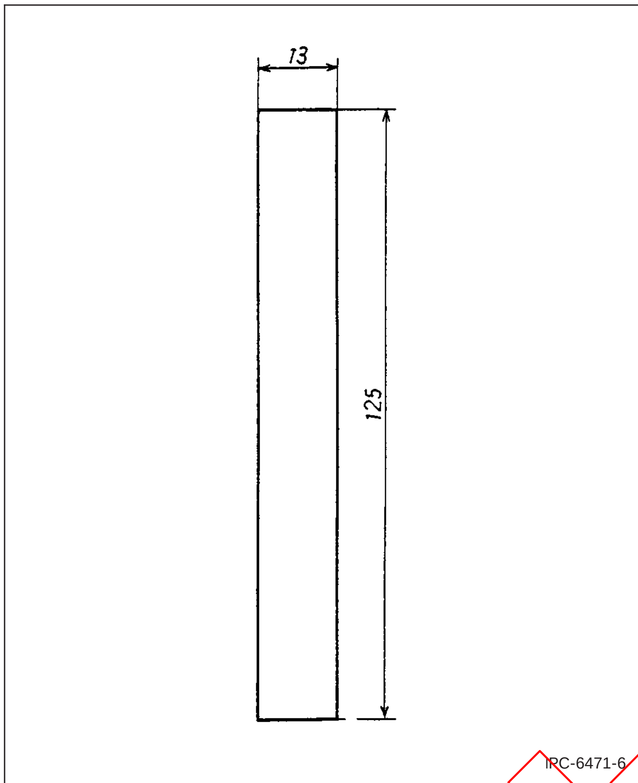


Figure 6 Specimen for Flame Retardance Test (1)

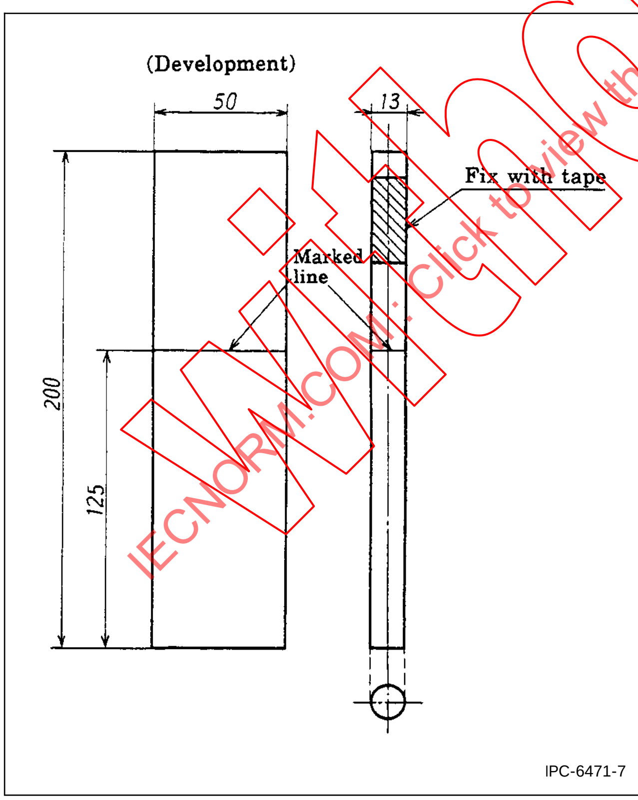


Figure 7 Specimen for Flame Retardance Test (2)

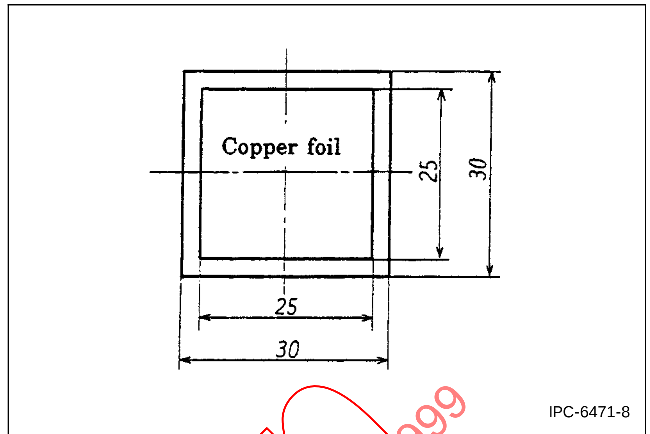


Figure 8 Specimen of Single-Sided Copper-Clad Laminate for Test for Resistance to Soldering Heat and Resistance to Chemicals

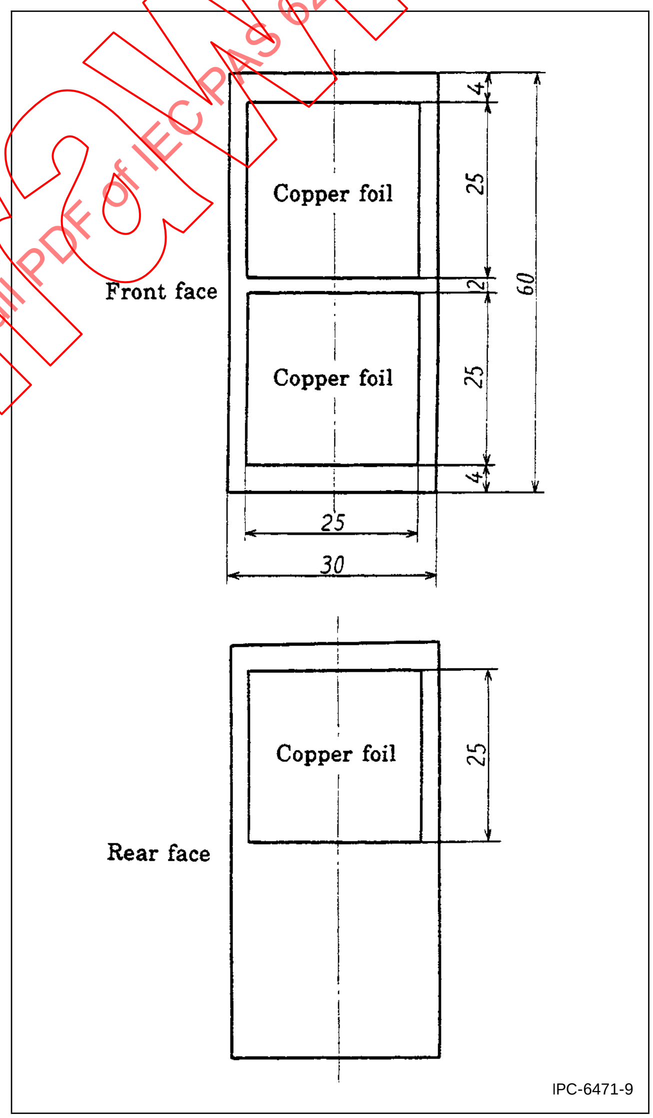


Figure 9 Specimen of Double-Sided Copper-Clad Laminate for Tests for Resistance to Soldering Heat and Resistance to Chemicals

In the case of single-sided copper-clad laminate, either the conductive coating or adhered copper foil may be used for the counter electrode.

When the conductive coating is used as the electrode, it shall have been coated before the preconditioning is made.

7.1.3 Preconditioning The preconditioning shall comply with the specification of Section 5.

7.1.4 Tests The tests shall be as stated in 7.1.4.1 through 7.1.4.2.3.

7.1.4.1 Normal State

7.1.4.1.1 Measurement When the measurement is made under normal state, measure the thickness of the specimen after preconditioning by the electrical comparator to the nearest 0.1 g and measure the inside diameter of the ring-shaped clearance of the upper electrode using the Vernier caliper to the nearest 0.05 mm.

Apply DC voltage of 500 V ± 5 V and measure the volume resistivity after one minute.

7.1.4.1.2 Calculation Calculate the volume resistivity ρ_v (Ω-cm) from the following formula:

$$\rho_v = \frac{\pi d^2}{4t} \text{ x } R_v$$

where:

d : external diameter of the surface electrode (cm)
t : thickness of the insulation substrate (cm)
R_v : resistance (Ω)
π : ratio of circumference to its diameter

7.1.4.2 After Humidifying Treatment

7.1.4.2.1 Treatment Measure the dimensions of the pre-conditioned specimen the same as in the normal state test, then put the specimen in thermohygrostatic chamber at 40°C ± 1°C and 90% RH to 95% RH. Leave the specimen in the chamber for 96 hours +2, -0 hours, then take it out and place in a desiccator (for cooling) in which the humidity is controlled by the saturated water solution of sodium tartrate dehydrate specified in JIS K 8540 and the temperature is held at 20°C ± 2°C.

7.1.4.2.2 Measurement Take the specimen out of chamber within one hour from the end of treatment and complete the measurement of volume resistivity within three minutes in the same way as in 7.1.4.1.1.

7.1.4.2.3 Calculation Comply with 7.1.4.1.2.

7.2 Insulation Resistance, Surface Layers

7.2.1 Device The device shall be the same as the volume resistivity testing device of 7.1.1.

7.2.2 Specimen Prepare the specimens by making the electrode shown in Figure 2 by means of etching.

For double-sided copper-clad laminates, prepare two kinds of specimens (i.e., the conductive pattern is formed on the front and rear surfaces).

7.2.3 Preconditioning The preconditioning shall comply with the specification of Section 5.

7.2.4 Test The test shall be as stated in 7.2.4.1 through 7.2.4.2.2.

7.2.4.1 Normal State Apply a DC voltage of 500 V ± 5 V to the specimen and measure the insulation resistance after one minute with the voltage applied.

7.2.4.2 After Humidifying Treatment

7.2.4.2.1 Treatment The treatment shall comply with 7.1.4.2.

7.2.4.2.2 Test The test shall comply with 7.2.4.1.

7.3 Voltage Proof, Surface Layers

7.3.1 Device The device shall be that specified in 6.2 of JIS C 2110 or equivalent.

7.3.2 Specimen The specimen shall comply with 7.2.2. The specimens that cause mechanical damage, flashover (surface discharge), sparkover (discharge through air), or dielectric breakdown in this test shall not be used for other tests.

7.3.3 Preconditioning The preconditioning shall comply with the specification of Section 5.

7.3.4 Test Apply a voltage of 500 V to the specimen by using DC voltage or AC voltage at a frequency of 50 Hz or 60 Hz. Raise the voltage gradually to the specified voltage in about five seconds, maintain the voltage for one minute, and examine for the existence or nonexistence of such abnormalities as mechanical damage, flashover, sparkover, and dielectric breakdown.

7.4 Voltage Proof Between Layers

7.4.1 Device The device shall be the same one specified in 7.3.1.

7.4.2 Specimen The specimen shall comply with 7.1.2. The specimens that cause mechanical damage or dielectric breakdown in this test shall not be used in other tests.

7.4.3 Preconditioning The preconditioning shall comply with the specification of Section 5.

7.4.4 Test Carry out the test as specified in 7.3.4 and examine for the existence or nonexistence of such abnormalities as mechanical damage and dielectric breakdown.

7.5 Relative Permittivity and Dissipation Factor

7.5.1 Devices The devices shall be as stated in 7.5.1.1 through 7.5.1.5.

7.5.1.1 Power Source (S in Figure 10) The power source shall be able to generate a frequency of 1 MHz and apply specified voltage in a sinusoidal wave with a distortion factor ≤5% or to the specimen and shall be electrostatically and electromagnetically shielded in order to avoid the direct connection of the power source and balance detector.

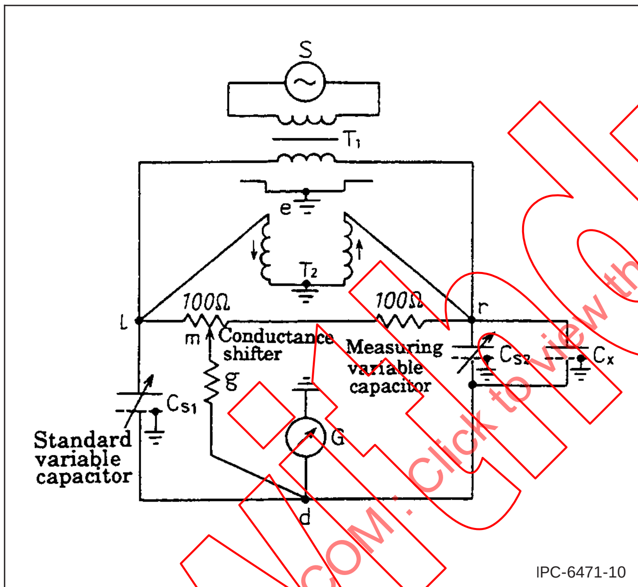


Figure 10 Example of Transformer Bridge Method Measuring Circuit for Relative Permittivity and issipation Factor Tests

7.5.1.2 Bridge

7.5.1.2.1 Shielding Transformer (T_1 in Figure 10) This is a transformer intended for matching of the internal impedance of the power source and the impedance of the bridge (about 200Ω) in which the windings in the bridge side are shielded by an earthen conductor. The windings in bridge side shall be split and balanced winding.

7.5.1.2.2 Ratio Arm (T_2 in Figure 10) Make the ratio arm by non-inductively connecting the primary and secondary windings of a transformer with a 1:1 turn ratio (error ≤0.2%) and small leakage inductance. Winding the resistance as far as possible, earth the connecting point as shown in e of Figure 10 and connect other two terminals with I and r.

7.5.1.2.3 Standard Variable Capacitor ($C_{S1}$and C_{S2} in Figure 10) Prepare two air capacitors equipped with the guard and total capacitance of about 200 pF; employ one as standard capacitor, C_{S1}, and the other as measuring capacitor, C_{S2}, and insert the specimen, Cx, parallel to the latter. It is desirable the capacitance changes slowly in the range of small capacitance and rapidly with the increase of capacitance in order to precisely determine the capacitance.

Moreover, it is desirable the residual resistance and residual inductance of C_{S1} and C_{S2} do not exceed 0.1Ω and 0.1 μH respectively.

7.5.1.2.4 Conductance Shifter In a component of the bridge in which a constant conductance (g in Figure 1) is inserted between m and d of Figure 10, the resistance between I and r is constant (200Ω), irrespective of the position of m. The resistance between I and m of Figure 10 is variable in the range 100Ω to 0Ω, and the resistance between m and r is variable in the range of 100Ω to 200Ω.

7.5.1.3 Equilibrium detecting device, G of Figure 10, which is responsible only to fundamental wave of power supply voltage applied to the bridge

7.5.1.4 Electrical comparator specified in JIS B 7536 or equivalent

7.5.1.5 Vernier caliper with a minimum reading of 0.05 mm specified in JIS B 7507 or equivalent measuring apparatus

7.5.2 Specimen Cut the sample into a 50 mm square with original thickness and make the electrode shown in Figure 3 by etching to prepare a specimen.

Arrange the form and dimensions of the electrodes so the centers of the main counter and guard electrodes coincide as far as possible and further make the clearance of the ring form between the main electrode and the guard to 1 mm ± 0.1 mm.

In the case of single-sided copper-clad laminates, prepare the specimen in the same way as in 7.1.2.

7.5.3 Preconditioning The preconditioning shall comply with the specification of Section 5.

7.5.4 Test The test shall be as stated in 7.5.4.1 and 7.5.4.2.

7.5.4.1 Measurement Measure the thickness of the specimen after preconditioning to the nearest 0.001 mm using the electrical comparator.

Using the Vernier caliper, measure the external diameter of the main electrode to the nearest 0.05 mm and confirm the ring form clearance between the main electrode and the guard is 1 mm ± 0.1 mm uniformly.

Connect the specimen after preconditioning per 3.3 to the position of Cx in Figure 10 and measure the value of the standard capacitor, C_{S1}, and the measuring capacitor, C_{S2}, the resistance between m and d of the conductance shifter, the resistance between I and m and m and r when the bridge is brought to equilibrium by adjusting the measuring capacitor, C_{S2}, and the conductance shifter.

The measuring frequency shall be 1 MHz.

7.5.4.2 Calculation Calculate the relative permittivity ε_r, and dissipation factor, tan (δ), from the following formulas given in 7.5.4.2.1 and 7.5.4.2.2.

7.5.4.2.1 Relative Permittivity

$$\varepsilon_r = \frac{C_x}{C_o}$$

where:

C_x : difference in capacitance between standard capacitor C_{S1} and the measuring capacitor, C_{S2}, when the bridge is in equilibrium (pF) (C_{S1} - C_{S2})

C_o : capacitance at ε_r = 1 calculated from the area of the main electrode and the thickness of the specimen (pF), which is calculated by the following formula:

$$C_o = \frac{r_2}{3.6t}$$

where:

r : radius of the main electrode (cm)
t : thickness of the specimen (cm)

7.5.4.2.2 Dissipation Factor

$$\delta = \frac{G_x}{2\pi f C_x}$$

where:

G_x : conductance of the specimen (S), which is calculated by the following formula:

$$G_x = G \frac{S}{100}$$

G : conductance between m and d of Figure 10 (S)
S : resistance between m and r of Figure 10 (Ω) – 100 (Ω)

$\frac{S}{100}$: resistance ratio at the equilibrium point of the conductance shifter
f : measuring frequency (Hz)
π : circular constant

8 MECHANICAL PERFORMANCE TEST

8.1 Peeling Strength of Copper Foil

8.1.1 Classification of Test Method There are two kinds of test methods for peel strength of copper foil as shown below:

Method A This is a method to peel off the copper foil 90° to the copper foil removed surface; unless otherwise specified, this method shall be employed.

Method B This is a method to peel of the copper foil 180° to the copper foil removed surface. This method may be used subject to agreement between the parties concerned, with acceptance in such cases where the film thickness <0.025 mm, it is difficult to fix the film to the supporting fixture so the film does not cause tenting or break due to the peeling load, or it is desired to quickly obtain approximate measured values.

8.1.2 Device

8.1.2.1 Such a tensile tester that the error is within ± 1% of the indicated value on the scale in the effective measuring range, the load at peeling falls within 15% to 85% of capacity of the tester and the crosshead speed can be maintained at about 50 mm/minute, and a recorder that can record continuously the peeling force

8.1.2.2 A supporting fixture (as illustrated in Figure 11 and Figure 12) that can maintain the angle between the peeling direction and the plane of the copper foil to be removed at 90° ± 5° when the copper foil is peeled from copper-clad laminate or a supporting fixture at least equivalent thereto in its function, when method A is applied.

8.1.2.3 Vernier caliper with minimum reading of 0.05 mm specified in JIS B 7507 or equivalent

8.1.2.4 The solder bath shall be a vessel in which the melted solder (H6OA or H63A specified.in JIS-2 3282) is contained to a depth ≥50 mm and control of the temperature of the solder in the defined position is possible within tolerances of ± 3°C, covering the range of 200°C to 300°C.

8.1.3 Specimen The specimen shall be as stated in 8.1.3.1 and 8.1.3.2.

8.1.3.1 Single-Sided Copper-Clad Laminate Prepare the test patterns of Figure 4 by etching. Prepare two specimens in each of MD and TD (i.e., four specimens in total).

8.1.3.2 Double-Sided Copper-Clad Laminate Remove all the copper on the rear surface of the specimen and prepare the test pattern of Figure 4 on the surface to be tested by etching.

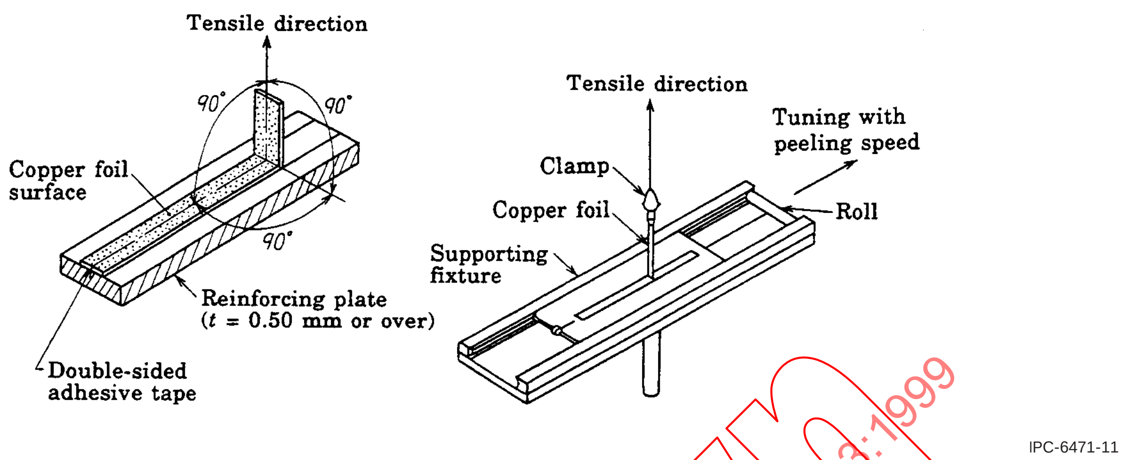


Figure 11 Slide Type Supporting Fixture for Measurement of Peel Strength by Method A (Peel Off in 90° Direction)

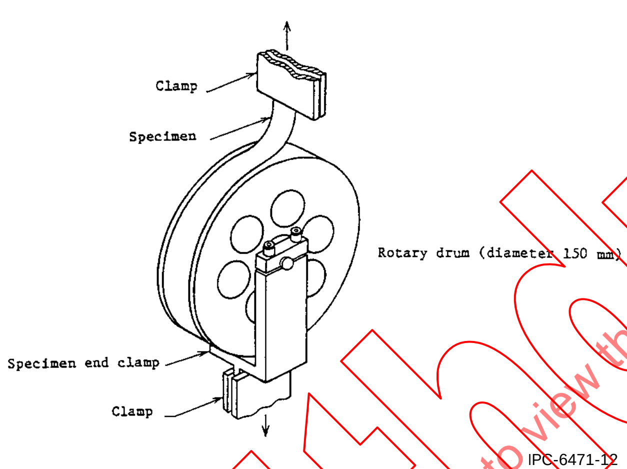


Figure 12 Rotary Drum Type Supporting Fixture for Measurement of Peel Strength Method A (Peel Off in 90° Direction)

Prepare two specimens in each surface to be tested in each of MD and TD (i.e., eight in total).

8.1.4 Preconditioning The preconditioning shall comply with the specification of Section 5.

8.1.5 Tests The tests shall be as stated in 8.1.5.1 through 8.1.5.4.

8.1.5.1 Normal State After preconditioning of the specimen, carry out the test as specified in 8.1.6.

8.1.5.2 After Heat Treatment Maintain the specimens vertically for one hour in an air-circulating thermostatic chamber at 130°C ± 5°C in the case of PET, and at 180°C ± 5°C in the case of PIA and PIB, allow them to stand under the standard test conditions of 3.1 for 24 hours ± 4 hours, then carry out the test as specified in 8.1.6.

8.1.5.3 After Solder Immersion Treatment (Not Applicable for Copper-Clad Laminates Employing PET as Base) Maintain the specimens in an air-circulating thermostatic chamber at 105°C ± 5°C for one hour or more, float them immediately on molten solder specified in 8.1.2.4 at 260°C ± 5°C for 5 +1,-0 seconds, allow them to stand under the standard test condition specified in 3.1 for 24 hours ± 4 hours, then carry out the test as specified in 8.1.6.

At the time of immersion in solder, cover the copper foil surface with masking tape or treat the specimens by immersing them into heat resistant silicone oil at 260°C or the like so the solder does not adhere to the copper foil surface.

8.1.5.4 After Chemical Immersion Treatment Maintain the specimen in chemicals at 23°C ± 5°C for five minutes, take it out and completely wipe off the chemicals, allow it to stand under the standard test conditions of 3.1 for 24 hours ± 4 hours, and carry out the test in accordance with 8.1.6.

However, in the case of inorganic chemicals, take the specimen out of the chemicals, completely wash it with water, dry it at 80°C ± 5°C for 30 min, allow it to stand under the standard test conditions specified in 3.1 for 24 hours ± 4 hours, then carry out the test.

Use the hydrochloric acid (2 mol/dm^3) as acid, the aqueous solution of sodium hydroxide (2 mol/dm^3) as alkali, and the 2-propanol specified in JIS K 8839 as alcohol. Carry out the tests on all the chemicals as specified in 8.1.6.

8.1.6 Measurement The measuring methods are as given in 8.1.6.1 through 8.1.6.2.

8.1.6.1 Method A (Method to Peel Off at 90°)

8.1.6.1.1 Measure the conductor width of the specimen and fix the specimen to the tensile tester. To ensure peeling at 90°, fix the specimen by pasting it to a reinforcing plate with double-sided adhesive tape so no slip or uneven force appears as illustrated in Figure 11. The supporting fixture shown in Figure 11, which can slide in the direction vertical to the tensile direction, synchronizing the speed of peeling together with the above assembly or that the specimen is firmly fixed by using two-sided adhesive tape to the freely rotatable drum illustrated in Figure 12.

Continuously peel off the copper foil vertical to the specimen surface to ≥50 mm and measure the load during the above procedure.

8.1.6.1.2 In the progress of peeling, read the value of the load at three points or more per second by using an adequate digital type recorder. Record the average value over every one second and take the minimum value in the average values so obtained as the peeling load (N) of the specimen. Exclude the load value in the first five seconds to eliminate the overshoot at the initial stage of peeling.

8.1.6.1.3 The peeling load of the specimen may be determined by the following procedure.

Draw the load continuously as exemplified in Figure 13, Figure 14, and Figure 15 by using an adequate analog type recorder and determine the average value of load by placing a straightedge on the portion where the loads are stable, excluding the initial overshoot (stable portion in Figure 13 and Figure 14).

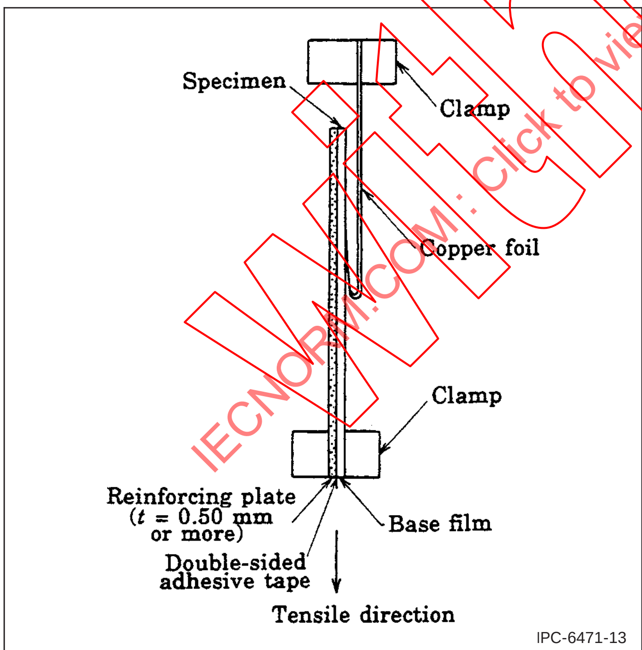


Figure 13 Mounting Method of Specimen for Measurement of Peel Strength by Method B (Peel Off in 180° Direction)

In this procedure, if the peeling mode changes in the way of peeling as exemplified in Figure 14, take the minimum value among the average values estimated at every stable portion as the peeling load.

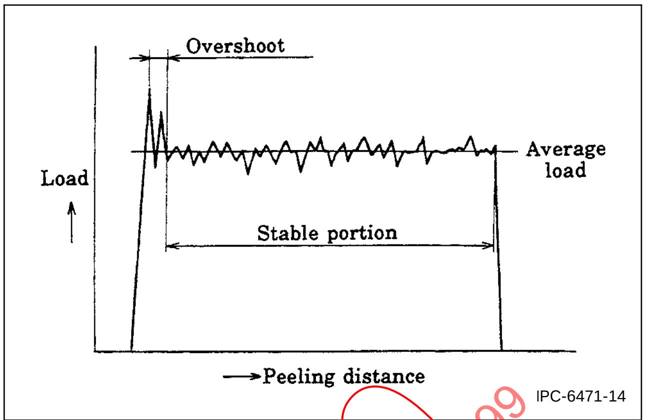


Figure 14 Uniform Peeling Mode

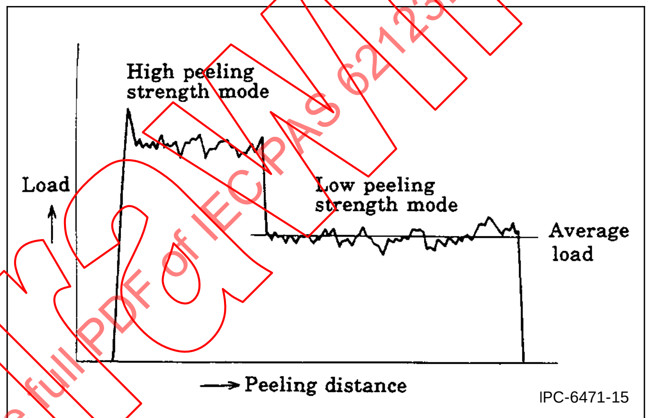


Figure 15 Non-Uniform Peeling Mode

If there is no stable portion in the peeling made as exemplified in Figure 15, take the minimum load as the peeling load (N).

8.1.6.1.4 Obtain the quotient of the peeling load (N) on each specimen by the width of the peeled conductor of the specimen (mm) and take the minimum value of the quotients so obtained as the peel strength of the specimen (N/mm).

8.1.6.1.5 Report the peel strength on both of specimens in MD and TD.

8.1.6.2 Method B (Method to Peel Off at 180°)

8.1.6.2.1 As in method A, fix the specimen whose conductor width has been measured to the tensile tester as illustrated in Figure 16. To ensure peeling at 180°, fix the specimen by pasting it to a reinforcing plate by double-sided adhesive tape so that no slip or uneven force appears.

8.1.6.2.2 The following measurement procedures and the calculation method of peeling strength shall be the same as those given in method A.

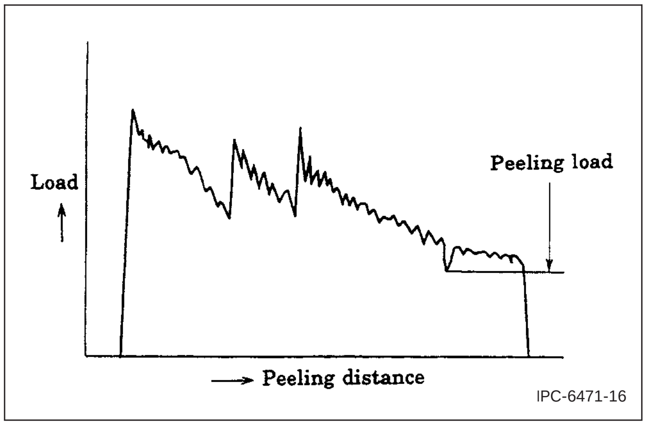


Figure 16 Peeling Mode without Stable Portion

8.2 Resistance to Folding

8.2.1 Device Use the folding resistance tester as shown in Figure 17 as the device.

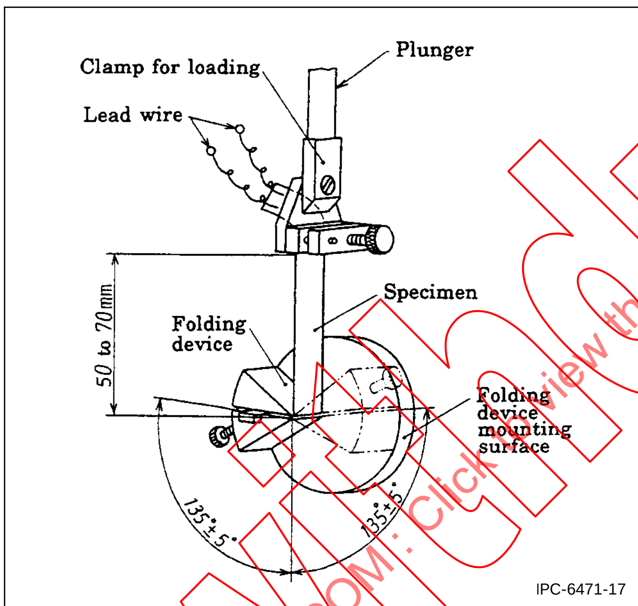


Figure 17 Example of Folding Resistance Tester

8.2.1.1 The clamps for loading the specimen shall move perpendicularly to the rotating axis of the folding device. The surface on which the specimen is to be mounted shall be in the same plane as the rotating axis. The load shall be capable of applying a tension in the range of 0 N to 14.7 N to the specimen.

Further, the distance between the clamp and the rotating axis at the time of load application shall be 50 mm to 75 mm.

8.2.1.2 The folding device shall have parallel and smooth folding faces and shall be placed symmetrically to the rotating axis.

The position of the rotating axis shall be on the tangential plane of the two folding faces and in the center thereof. The folding device shall be equipped with a clamp and its motion shall be such that the specimen is folded by an angle of 135° ± 5° to left and right of the unfolded position.

Each folding face shall have a radius of curvature of 2 mm and its width shall be not more than 19 mm. It is necessary the clearance between folding faces is larger than the thickness of specimen but it shall not exceed the thickness of the specimen not compressed by more than 0.25 mm.

8.2.1.3 There shall be a power-driving device to give the folding device a constant rotary motion.

8.2.1.4 There shall be a device to measure the number of reciprocal folding motions of the specimen.

8.2.2 Specimen Prepare the test pattern shown in Figure 5 as in 8.1.3.

8.2.3 Preconditioning The preconditioning shall comply with the specification of Section 5.

8.2.4 Test Apply the load corresponding to the tension necessary for the specimen to the plunger and stop the plunger at its original position. Attach the specimen accurately so it conforms a plane without being in contact with the folding device mounting surface.

Handle the specimen by holding its two ends so the folding part does not come in contact with the hand. Loosen the setscrew of the plunger and apply the load. If the reading of the load indicator changes, correct the load to the reading of the indicator at the time of the load application by means of the adjusting screw. Carry out the folding at a tension of 4.9 N and a rate of about 175 times per minute, measure the number of times until the specimen breaks, and take the mean value as the number of times denoting the resistance to folding.

9 OTHER TESTS

9.1 Flame Retardance

9.1.1 Devices The devices shall be as in 9.1.1.1 through 9.1.1.9.

9.1.1.1 A test chamber that can prepare draft-free conditions. It is desirable to use an enclosed hood equipped with a heat resistant glass window and an exhaust fan to remove smoke, gas, etc., after the test.

9.1.1.2 Stand for experiment equipped with one gripping tool

9.1.1.3 Bunsen burner with bore of ϕ 9.5 ± 0.5 mm and a tube length of about 100 mm that uses methane or natural gas of calorific value about 37 MJ/m^3 as the fuel

9.1.1.4 Stopwatch or timer

9.1.1.5 Absorbent cotton; 50 mm x 50 mm and maximum natural thickness of 6.4 mm

9.1.1.6 Desiccator containing calcium chloric anhydride

9.1.1.7 Test chamber that can maintain the inside atmosphere at 23°C ± 2°C and 50% RH ± 5% RH

9.1.1.8 A test cabinet that can maintain its temperature at 70°C ± 1°C

9.1.1.9 Mandrel with a diameter of 13 mm ± 0.5 mm

9.1.2 Specimen Prepare the specimens employing either the shape given in Figure 6 or Figure 7 formed by etching. However, use the shape of Figure 7, when the specimen is thin and easily deformed and contracted and the test of 9.1.4.4 is difficult.

9.1.2.1 The specimen of Figure 6 is 125 mm ± 0.5 mm in length and 13 mm ± 0.5 mm in width. Prepare two groups; five specimens being one group.

9.1.2.2 The specimen of Figure 7 is 200 mm in length and 50 mm in width and is marked with a line 125 mm from the bottom side in TD. Wind the specimen with the marked line in outside around the mandrel, fix the position within 76 mm in the upper side of the marked line by pressure sensitive adhesive tape, and pull out the mandrel to make the sample cylindrical form. If the specimen is difficult to become cylindrical owing to static electricity, discharge it by adequate method. If it is funnel-shaped, it is allowable if the other end is cylindrical. Prepare two groups of such specimens; five specimens being a group.

9.1.3 Preconditioning Carry out the preconditioning under the conditions of 9.1.3.1 and 9.1.3.2.

9.1.3.1 Allow the specimens to stand under the referee test conditions specified in 3.3 for at least 48 hours.

9.1.3.2 Heat the five specimens of the other group at 70°C ± 1°C for 168 hours in an air circulating type thermostatic chamber, put them into a desiccator containing calcium chloric anhydride, and store them at 23°C for at least four hours.

9.1.4 Test

9.1.4.1 Test each group of five specimens preconditioned under the conditions of 9.1.3.1 and 9.1.3.2.

9.1.4.2 Hold the specimen vertical using the clamp of the ring stand as shown in Figure 18 and determine the position of the specimen so the top end of the burner is 10 mm under and the horizontal surface of the absorbent cotton is 300 mm under the end of the specimen.

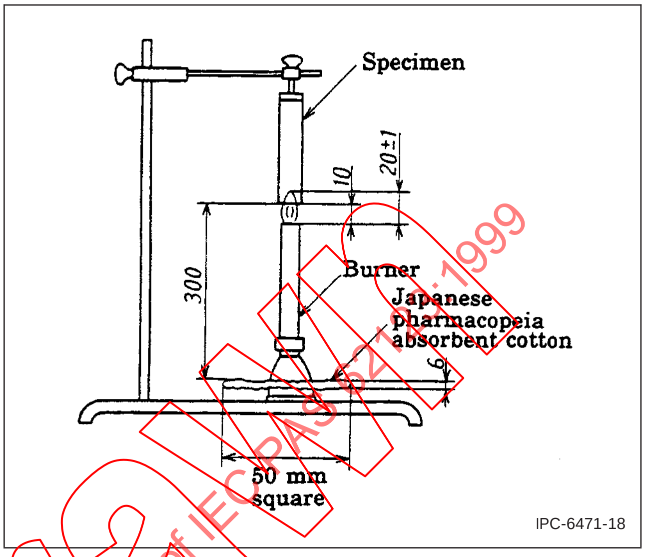


Figure 18 Flame Retardance Test Method

9.1.4.3 Ignite the burner at a position distant from the specimen and adjust it to produce blue flame with a length 20 mm ± 1 mm. Control the supplied amount of gas and air hole of the burner to make the length of the flame 20 mm ± 1 mm and extinguish the top yellow flame. Measure the length of flame again and readjust if necessary.

9.1.4.4 In the case of specimens as shown in Figure 6, apply the flame to the center of the bottom end of specimen for 10 seconds. Keep the flame away by 150 mm or more and record the flaming time. When the flame distinguishes, immediately apply the flame again to the bottom end of the specimen for 10 seconds, keep the flame away in the same way, and measure the flaming and glowing time thereafter until it reaches the gripping tool.

Record the existence or nonexistence of igniting of the absorbent cotton. In the previous procedures, if the molten pieces or flaming matters drop from the specimen, the burner may be inclined by 45° and may be displaced a little from the center of the bottom end of the specimen, during the approach of flame, to avoid drops of materials into the burner tube. In this case, too, the distance between under the end of the sample and the top end of the burner must be held to 10 mm.

9.1.4.5 In the case of specimens as shown in Figure 7, carry out the test in the same way as in 9.1.4.4 but make the duration of the flame application to the bottom end of specimen three seconds.

Measure the time of the flaming and glowing until the burning reaches the marked line.