



ASSOCIATION CONNECTING  
ELECTRONICS INDUSTRIES®

IPC-6013A

# Qualification and Performance Specification for Flexible Printed Boards

Developed by the Flexible Circuits Performance Specifications  
Subcommittee (D-12) of the Flexible Circuits Committee (D-10)  
of IPC

***Supersedes:***

IPC-6013 with  
Amendment 1

Includes:

IPC-6013 - November 1998

Amendment 1 - April 2000

IPC-RF-245 - April 1987

IPC-FC-250A - January 1974

Users of this publication 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

# Table of Contents

<b>1 SCOPE</b> .....	1	3.3.6	Plating Adhesion .....	10
1.1 Purpose .....	1	3.3.7	Edge Board Contact, Junction of Gold Plate to Solder Finish .....	10
1.2 Performance Classification, Wiring Type, and Installation Usage .....	1	3.3.8	Lifted Lands .....	10
1.2.1 Classification .....	1	3.3.9	Workmanship .....	10
1.2.2 Wiring Type .....	1	3.4	Dimensional Requirements .....	10
1.2.3 Installation Uses .....	1	3.4.1	Hole Size and Hole Pattern Accuracy .....	10
1.2.4 Selection for Procurement .....	1	3.4.2	Etched Annular Ring and Breakout (Internal) ..	10
1.2.5 Material, Plating Process and Final Finish .....	1	3.4.3	Etched Annular Ring (External) .....	10
1.3 Interpretation .....	2	3.4.4	Bow and Twist (Individual Rigid or Stiffener Portions Only) .....	12
<b>2 APPLICABLE DOCUMENTS</b> .....	2	3.5	Conductor Definition .....	12
2.1 IPC .....	2	3.5.1	Conductor Imperfections .....	13
2.2 Joint Industry Standards .....	4	3.5.2	Conductor Spacing .....	13
2.3 Federal .....	4	3.5.3	Conductive Surfaces .....	13
2.4 American Society for Testing and Materials .....	4	3.6	Physical Requirements .....	14
2.5 National Electrical Manufacturers Association ...	4	3.6.1	Bending Test .....	14
2.6 American Society for Quality .....	4	3.6.2	Flexible Endurance .....	14
<b>3 REQUIREMENTS</b> .....	4	3.6.3	Bond Strength (Unsupported Lands) .....	14
3.1 Terms and Definitions .....	4	3.6.4	Bond Strength (Stiffener) .....	14
3.1.1 Coverlayer .....	4	3.7	Structural Integrity .....	14
3.1.2 Coverfilm .....	4	3.7.1	Thermal Stress Testing .....	15
3.1.3 Covercoat .....	4	3.7.2	Requirements for Microsectioned Coupons .....	15
3.2 Material .....	4	3.7.3	Flexible Laminate Integrity .....	15
3.2.1 Flexible Material Options .....	4	3.7.4	Rigid Laminate Integrity .....	15
3.2.2 Laminates and Bonding Material for Multilayer Flexible Printed Wiring .....	4	3.7.5	Etchback (Type 3 and Type 4 Only) .....	15
3.2.3 External Bonding Materials .....	5	3.7.6	Smear Removal (Type 3 and Type 4 Only) .....	15
3.2.4 Other Dielectric Materials .....	5	3.7.7	Negative Etchback .....	15
3.2.5 Metal Foils .....	5	3.7.8	Plating Integrity .....	15
3.2.6 Metallic Platings and Coatings .....	5	3.7.9	Plating Voids .....	16
3.2.7 Organic Solderability Protective Coatings (OSP) .....	5	3.7.10	Annular Ring (Internal) .....	17
3.2.8 Solder Resist .....	5	3.7.11	Plating/Coating Thickness .....	17
3.2.9 Fusing Fluids and Fluxes .....	5	3.7.12	Minimum Layer Copper Foil Thickness .....	17
3.2.10 Marking Inks .....	6	3.7.13	Minimum Surface Conductor Thickness .....	17
3.2.11 Hole Fill Insulation Material .....	6	3.7.14	Metal Cores .....	17
3.2.12 Heatsink Planes, External .....	6	3.7.15	Dielectric Thickness .....	17
3.3 Visual Examination .....	6	3.7.16	Resin Fill of Blind and Buried Vias .....	17
3.3.1 Profile .....	6	3.8	Rework Simulation .....	17
3.3.2 Construction Imperfections - Rigid .....	6	3.9	Electrical Requirements .....	19
3.3.3 Plating and Coating Voids in the Hole .....	9	3.9.1	Dielectric Withstanding Voltage .....	19
3.3.4 Marking .....	9	3.9.2	Circuitry .....	19
3.3.5 Solderability .....	9	3.9.3	Circuit/Plated-Through Hole Shorts to Metal Substrates .....	20
		3.9.4	Insulation Resistance (As Received) .....	20

3.10 Environmental Requirements ..... 20

3.10.1 Moisture and Insulation Resistance ..... 20

3.10.2 Thermal Shock ..... 20

3.10.3 Cleanliness ..... 20

3.10.4 Organic Contamination ..... 20

3.10.5 Fungus Resistance ..... 20

3.11 Special Requirements ..... 20

3.11.1 Outgassing ..... 21

3.11.2 Impedance Testing ..... 21

3.11.3 Repair ..... 21

3.11.4 Circuit Repair ..... 21

3.11.5 Rework ..... 21

3.11.6 Coefficient of Thermal Expansion (CTE) ..... 21

**4 QUALITY ASSURANCE PROVISIONS** ..... 21

4.1 Qualification ..... 21

4.1.1 Sample Test Specimen ..... 21

4.2 Acceptance Testing and Frequency ..... 24

4.2.1 Referee Tests ..... 24

4.3 Quality Conformance Testing ..... 24

4.3.1 Coupon Selection ..... 28

**5 NOTES** ..... 28

5.1 Ordering Data ..... 28

5.2 Superseded Specifications ..... 28

**APPENDIX A** ..... 29

**Figures**

Figure 3-1 Transition Zone ..... 7

Figure 3-2 Unacceptable Covercoat Coverage ..... 8

Figure 3-3 Solder Wicking and Plating Penetration ..... 9

Figure 3-4 Annular Ring Measurement (Internal) ..... 11

Figure 3-5 Annular Ring Measurement (External) ..... 11

Figure 3-6 Breakout of 90° and 180° ..... 12

Figure 3-7 Conductor Width Reduction ..... 12

Figure 3-8 Squeeze-Out of Cover Film Adhesive and Ooze-Out of Covercoat ..... 12

Figure 3-9 Bending Test ..... 14

Figure 3-10 Separation at External Foil ..... 17

Figure 3-11 Crack Definition ..... 17

Figure 3-12 Typical Microsection Evaluation Specimen (Three Plated-Through Holes) ..... 18

Figure 3-13 Etchback Depth Allowance ..... 18

Figure 3-14 Smear Removal Allowance ..... 18

Figure 3-15 Negative Etchback ..... 19

**Tables**

Table 1-1 Final Finish, Surface Plating and Coating Thickness Requirements ..... 3

Table 3-1 Covercoat Adhesion ..... 8

Table 3-2 Solder Wicking/Plating Penetration Limits ..... 9

Table 3-3 Plating and Coating Voids Visual Examination ... 9

Table 3-4 Edge Board Contact Gap ..... 10

Table 3-5 Minimum Etch Annular Ring ..... 11

Table 3-6 Allowable Squeeze-Out of Coverlayer Adhesive and Ooze-Out of Covercoat ..... 12

Table 3-7 Minimum Solderable Annular Ring on Land Area ..... 12

Table 3-8 Conductor Spacing Requirements ..... 13

Table 3-9 Plated-Through Hole Integrity After Stress ..... 16

Table 3-10 Conductor Thickness After Processing ..... 19

Table 3-11 External Conductor Thickness After Plating .... 19

Table 3-12 Dielectric Withstanding Test Voltages ..... 19

Table 3-13 Insulation Resistance ..... 20

Table 4-1 Qualification Testing ..... 22

Table 4-2 C=0 Sampling Plan for Equipment Classes per Lot Size ..... 24

Table 4-3 Acceptance Testing and Frequency ..... 25

Table 4-4 Quality Conformance Testing ..... 27

# Qualification and Performance Specification for Flexible Printed Boards

## 1 SCOPE

This specification covers qualification and performance requirements of flexible printed wiring. The flexible printed wiring may be single-sided, double-sided, multilayer, or rigid-flex multilayer. All of these constructions may or may not include stiffeners, plated-through holes, and blind/buried vias.

**1.1 Purpose** The purpose of this specification is to provide requirements for qualification and performance of flexible printed wiring designed to IPC-2221 and IPC-2223.

### 1.2 Performance Classification, Wiring Type, and Installation Usage

**1.2.1 Classification** This specification recognizes that flexible printed wiring will be subject to variations in performance requirements based on end-use. These performance classes (Class 1, Class 2, and Class 3) are defined in IPC-6011.

**1.2.2 Wiring Type** Performance requirements are established for the different types of flexible printed wiring, classified as follows:

- Type 1 Single-sided flexible printed wiring containing one conductive layer, with or without stiffeners.
- Type 2 Double-sided flexible printed wiring containing two conductive layers with plated-through holes, with or without stiffeners.
- Type 3 Multilayer flexible printed wiring containing three or more conductive layers with plated-through holes, with or without stiffeners.
- Type 4 Multilayer rigid and flexible material combinations containing three or more conductive layers with plated-through holes.
- Type 5 Flexible or rigid-flex printed wiring containing two or more conductive layers without plated-through holes.

#### 1.2.3 Installation Uses

- Use A Capable of withstanding flex during installation.
- Use B Capable of withstanding continuous flexing for the number of cycles as specified on the procurement documentation.
- Use C High temperature environment (over 105 °C [221 °F]).
- Use D UL Recognition.

**1.2.4 Selection for Procurement** For procurement purposes, performance class and installation usage **shall** be specified in the procurement documentation.

The documentation **shall** provide sufficient information to the supplier so that the supplier can fabricate the flexible printed wiring and ensure that the user receives the desired product. Information that should be included in the procurement documentation is shown in IPC-D-325.

**1.2.4.1 Selection (Default)** The procurement documentation should specify the requirements that can be selected within this specification. However, in the event that these selections are not made in the documentation, the following default selections **shall** apply:

Performance Class – Class 2  
Installation Usage – Use A

### 1.2.5 Material, Plating Process and Final Finish

**1.2.5.1 Laminate Material** Laminate material is identified by numbers and/or letters, classes and types as specified by the appropriate specification listed in the procurement documentation.

**1.2.5.2 Plating Process** The copper plating process used to provide the main conductor in the holes is identified by a single number as follows:

1. Acid copper electroplating only.
2. Pyrophosphate copper electroplating only.
3. Acid and/or pyrophosphate copper electroplating.
4. Additive/electroless copper.

**1.2.5.3 Final Finish** The final finish can be but is not limited to one of the designators given below or a combination of several platings and is dependent on assembly processes and end-use. The procurement documentation **shall** specify finish designators. Unless otherwise specified, thicknesses given in Table 1-1 **shall** apply.

S	Solder Coating (Table 1-1)
T	Electrodeposited Tin-Lead (fused) (Table 1-1)
X	Either Type S or T (Table 1-1)
TLU	Electrodeposited Tin-Lead (unfused) (Table 1-1)
G	Gold Electroplate for Edge Board Connectors (Table 1-1)
GS	Gold Electroplate for Areas to be Soldered (Table 1-1)