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-6013A with Amendment 2 - April 2006
IPC-6013A with Amendment 1 - January 2005
IPC-6013A - November 2003
Amendment 1 - December 2005
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
3000 Lakeside Drive, Suite 309S
Bannockburn, Illinois
60015-1219
Tel 847 615.7100
Fax 847 615.7105
Table of Contents

1 SCOPE ................................................................. 1
1.1 Statement of Scope ............................................. 1
1.2 Purpose .......................................................... 1
1.3 Performance Classification, PB Type, and Installation Usage ............................................. 1
1.3.1 Classification .................................................. 1
1.3.2 PB Type .......................................................... 1
1.3.3 Installation Uses ............................................. 1
1.3.4 AMS ............................................................... 4
1.3.5 American Society of Mechanical Engineers ............................................. 4
1.3.6 Federal ............................................................ 4
1.4 Terms and Definitions .......................................... 2
1.4.1 As Agreed Upon Between User and Supplier (AABUS) ............................................. 2
1.4.2 Overlay .......................................................... 2
1.4.3 Coverfilm ....................................................... 2
1.4.4 Covercoat ....................................................... 2
1.4.5 Cover Material .................................................. 3
1.5 Interpretation “Shall” .......................................... 3
1.6 Presentation ...................................................... 3
1.7 Revision Level Changes ...................................... 3

2 APPLICABLE DOCUMENTS ........................................ 3
2.1 IPC ................................................................ 3
2.2 Joint Industry Standards ......................................... 4
2.3 Other Publications .................................................. 4
2.3.1 American Society for Testing and Materials ............................................. 4
2.3.2 National Electrical Manufacturers Association ............................................. 4
2.3.3 American Society for Quality ............................................. 4
2.3.4 AMS ............................................................... 4
2.3.5 American Society of Mechanical Engineers ............................................. 4
2.3.6 Federal ............................................................ 4

3 REQUIREMENTS ....................................................... 4
3.1 General .......................................................... 4
3.2 Materials Used in this Specification ....................... 5
3.2.1 Laminates and Bonding Materials ................. 5
3.2.2 External Bonding Materials .............................. 5
3.2.3 Other Dielectric Materials .............................. 5
3.2.4 Metal Foils ....................................................... 5
3.2.5 Metal Planes/Cores ........................................... 5
3.2.6 Metallic Platings and Coatings ....................... 5
3.2.7 Organic Solderability Protective Coatings (OSP) ............................................. 7
3.2.8 Polymer Coating (Solder Mask) ....................... 7
3.2.9 Fusing Fluids and Fluxes ................................. 7
3.2.10 Marking Inks .................................................. 7
3.2.11 Hole Fill Insulation Material ............................. 8
3.2.12 Heatsink Planes, External ............................. 8
3.2.13 Via Protection .................................................. 8
3.2.14 Embedded Passive Materials ......................... 8
3.3 Visual Examination ........................................... 8
3.3.1 Profile ............................................................. 8
3.3.2 Construction Imperfections ............................................. 8
3.3.3 Plating and Coating Voids in the Hole .................. 11
3.3.4 Lifted Lands ..................................................... 11
3.3.5 Marking ............................................................. 11
3.3.6 Solderability ....................................................... 12
3.3.7 Plating Adhesion ............................................... 12
3.3.8 Edge Board Contact, Junction of Gold Plate to Solder Finish ............................................. 12
3.3.9 Workmanship ..................................................... 12
3.4 Dimensional Requirements ................................... 13
3.4.1 Hole Size, Hole Pattern Accuracy and Pattern Feature Accuracy ............................................. 13
3.4.2 Annular Ring and Breakout (External) .................. 13
3.4.3 Bow and Twist (Individual Rigid or Stiffener Portions Only) ............................................. 15
3.4.4 Conductor Definition ......................................... 16
3.4.5 Conductor Width and Thickness ............................. 16
3.4.6 Conductor Spacing ............................................. 16
3.4.7 Conductor Imperfections ..................................... 16
3.4.8 Conductive Surfaces ........................................... 17
3.4.9 Structural Integrity ............................................. 18
3.4.10 Thermal Stress Testing ...................................... 18
3.4.11 Requirements for Microsectioned Coupons or Production PBs ............................................. 19
3.4.12 Solder Mask Requirements ............................... 26
3.4.13 Solder Mask Coverage ....................................... 26
3.4.14 Solder Mask Cure and Adhesion ......................... 27
3.4.15 Solder Mask Thickness ....................................... 27
3.4.16 Electrical Requirements .................................... 27
3.4.17 Dielectric Withstanding Voltage ......................... 27
3.4.18 Electrical Continuity and Isolation Resistance ............................................. 27
3.4.19 Circuit/PTH Shorts to Metal Substrates .................. 28
3.4.20 Moisture and Insulation Resistance (MIR) ............... 28
3.4.21 Cleanliness ....................................................... 28
Table 3-5  Stiffener Void Limits as a Percentage of Stiffener Surface Area ................................... 11
Table 3-6  Plating and Coating Voids Visual Examination ............................................................ 12
Table 3-7  Edge Board Contact Gap .......................................................... 12
Table 3-8  Minimum Etch Annular Ring .......................................................... 13
Table 3-9  Allowable Squeeze-Out of Coverlay Adhesive and Ooze-Out of Covercoat .......... 14
Table 3-10  Minimum Solderable Annular Ring on Land Area ......................................................... 15
Table 3-11  Conductor Spacing Requirements .......................................................... 16
Table 3-12  Plated-Through Hole Integrity After Stress .......................................................... 19
Table 3-13  Internal Layer Foil Thickness after Processing .......................................................... 25
Table 3-14  External Conductor Thickness after Plating .......................................................... 25
Table 3-15  Solder Mask Adhesion .......................................................... 27
Table 3-16  Dielectric Withstanding Test Voltages ......................................................... 28
Table 3-17  Insulation Resistance .......................................................... 28
Table 4-1  Qualification Testing .......................................................... 31
Table 4-2  C=0 Sampling Plan for Equipment Classes per Lot Size .................................................. 34
Table 4-3  Acceptance Testing and Frequency ......................................................... 34
Table 4-4  Quality Conformance Testing .......................................................... 38
1 SCOPE

1.1 Statement of Scope  This specification covers qualification and performance requirements of flexible printed boards (PBs). The flexible PB may be single-sided, double-sided, multilayer, or rigid-flex multilayer. All of these constructions may or may not include stiffeners, plated-through holes (PTHs), and blind/buried vias.

The flexible or rigid-flex PB may contain build up high density interconnect (HDI) layers conforming to IPC-6016. The PB may contain active embedded passive circuitry with distributive capacitive planes, capacitive or resistive components.

The rigid section of the PB may contain a metal core or external metal heat frame, which may be active or nonactive.

Revision level changes are described in 1.7.

1.2 Purpose  The purpose of this specification is to provide requirements for qualification and performance of flexible PBs designed to IPC-2221 and IPC-2223.

1.3 Performance Classification, PB Type, and Installation Usage

1.3.1 Classification  This specification recognizes that flexible PBs 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.

1.3.2 PB Type  Performance requirements are established for the different types of flexible PBs, classified as follows:

Type 1  Single-sided flexible PBs containing one conductive layer, with or without stiffeners.

Type 2  Double-sided flexible PBs containing two conductive layers with PTHs, with or without stiffeners.

Type 3  Multilayer flexible PBs containing three or more conductive layers with PTHs, with or without stiffeners.

Type 4  Multilayer rigid and flexible material combinations containing three or more conductive layers with PTHs.

Type 5  Flexible or rigid-flex PBs containing two or more conductive layers without PTHs.

1.3.3 Installation Uses

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

1.3.4 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 PBs and ensure that the user receives the desired product. Information that should be included in the procurement documentation is shown in IPC-D-325.

Note: If the drawing specifies the requirement in words, designators are not required.

1.3.4.1 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, Table 1-1 shall apply:

1.3.5 Material, Plating Process and Final Finish

1.3.5.1 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.

1.3.5.2 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
5. Electrodeposited Nickel underplate with copper electroplating

Note: Pyrophosphate copper electroplating is no longer in use.

1.3.5.3 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.