ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-6013

Qualification and Performance Specification for Flexible Printed Boards

Amendment 1

Approved American National Standard
ANSI
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IPC-6013

A standard developed by IPC

Amendment 1
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Qualification and Performance Specification for Flexible Printed Boards Amendment 1

1.1 Section now reads, ''The purpose of this specification is to provide requirements for qualification and performance of flexible printed wiring designed to IPC-2221/ IPC-2223.'' Due to this change, IPC-2221 and IPC-2223 **shall** be added to the list of IPC documents in 2.1.

Table 3-1 Correct numerical error in Table 3-1 at Gold (min.) for edge flexible printed wiring connectors and areas to be soldered. Class 1 should be ''0.8'' µm instead of ''0.4'' µm.

3.2.6.7 Replace MIL-G-45204 with ASTM B 488 due to cancellation of MIL-G-45204. Due to this change, 2.3 will be deleted, the subsequent sections renumbered and ASTM B 488 **shall** be added to the listing of ASTM documents in the newly renumbered 2.4.

3.3.2.9(a) Change 2.5 mm x 2.5 mm to 0.80 mm x 0.80 mm [0.0315 in x 0.0315 in].

Table 3-2 Delete (µm) units from the title block, ''Maximum Percentage Loss Allowed (µm).''

3.7.8 Change ''5%'' to ''50%.''

Table 4-1 Reformat Table 4-1, creating bold print for primary requirements, making corrections for test samples, and eliminating column entitled ''Board'' from the table.

4.2 Change section heading from **Quality Conformance Inspection** to **Acceptance Testing and Frequency**.

Delete:

Quality conformance inspection **shall** be as specified in Appendix A to the requirements.

Replace with:

Acceptance testing and frequency **shall** be as specified in Table 4-3 to the requirements.

Delete:

is indicated in Appendix A, use the C=0.

Replace with:

is indicated in Table 4-3, use the C=0.

Table 4-2 Under lot size 151-280, Class 3, change ''136'' to ''13.''

4.3 Change section heading from **Reliability Test and Evaluation** to **Quality Conformance Testing**.

Delete:

When specified by the user, reliability assurance inspection **shall** be performed and consist of inspections specified in Table 4-3. Reliability testing should be performed in a facility that meets the requirements of IPC-QL-653. Class 3 testing results may be extended to reliability test and evaluation for Class 2.

Replace with:

Quality Conformance Testing **shall** be performed and consist of inspections specified in Table 4-4 in a facility that meets the requirements of IPC-QL-653, unless otherwise specified by the user. Class 3 testing results may be extended to reliability test and evaluation for Class 2.

New Table 4-3 Modified table content by deleting ''X'' under 3.4.2 and adding ''X'' under 3.4.4.

Modified old Appendix A with notes after Appendix A to become new **''Table 4-3 Acceptance Testing and Frequency''** with new notes 1 and 2.

New Table 4-4 Renumbered Table 4-3 as **Table 4-4 Quality Conformance Testing.**

Cleaned up table headings to improve appearance.

Corrected Class 2 inspection frequencies.

Deleted thermal shock requirements.

NEW SECTION ADDED

5.2 Superseded Specifications This specification supersedes and replaces IPC-FC-250 and IPC-RF-245.

New Appendix A Added new Appendix A presenting the performance requirements in an abbreviated form in alphabetical order.

REVISED SECTION 4, SECTION 5, AND APPENDIX A

4 QUALITY ASSURANCE PROVISIONS

General quality assurance provisions are specified in IPC-6011 and each sectional specification. The requirements specific to flexible printed wiring are contained in this specification and include the qualification testing, sampling plan, quality performance testing and frequency, and reliability assurance inspection.

4.1 Qualification Qualification is as agreed upon by the user and supplier (see IPC-6011). The qualification should consist of pre-production samples, production sample, or test specimens (see IPC-6011) that are produced by the same equipment and procedures planned for the production boards. Qualification as agreed upon by the user may consist of documentation that the supplier has furnished similar product to other users or to other similar specifications.

4.1.1 Sample Test Specimen If test specimens are used in lieu of actual production lots, the following information is provided based on previous use of standardized test specimens. Sample test specimens may be used for qualification or for ongoing process control. Master drawings, databases, or phototools are available from IPC. For each type (see 1.2.2) the master drawing and phototool is listed as follows:

Type 1 Master Drawing IPC-100041, Phototool IPC-A-41
Type 2 Master Drawing IPC-100042, Phototool IPC-A-42
Type 3 Master Drawing IPC-100043, Phototool IPC-A-43
Type 4 Master Drawing IPC-100043, Phototool IPC-A-43
Type 5 Master Drawing IPC-100043, Phototool IPC-A-43

Note: IPC-100001 is the universal drilling and profile master drawing.

Table 4-1 specifies the test coupons from IPC-A-41, IPC-A-42, and IPC-A-43 to be used from the test specimen for qualification and process capability evaluations. Equivalent production board coupon descriptions can be found in IPC-2221.

Table 4-1 Qualification Testing

TEST	Requirement Paragraph	TYPE 1 & 5	TYPE 2	TYPE 3 & 4
Visual Examination	**3.3**			
Profile	3.3.1	Entire Board	Entire Board	Entire Board
Edges, Rigid Section	3.3.1.1	Entire Board	Entire Board	Entire Board
Edges, Flexible Section	3.3.1.2	Entire Board	Entire Board	Entire Board
Transition Zone, Rigid Area to Flexible Area	3.3.1.3	Entire Board	Entire Board	Entire Board
Construction Imperfections	3.3.2	Entire Board	Entire Board	Entire Board
Haloing	3.3.2.1	Entire Board	Entire Board	Entire Board
Measling and Crazing	3.3.2.2	Entire Board	Entire Board	Entire Board
Foreign Inclusions	3.3.2.3	Entire Board	Entire Board	Entire Board
Weave Exposure	3.3.2.4	Entire Board	Entire Board	Entire Board
Scratches, Dents, and Tool Marks	3.3.2.5	Entire Board	Entire Board	Entire Board
Surface Microvoids	3.3.2.6	Entire Board	Entire Board	Entire Board
Color Variations in Bond Enhancement Treatment	3.3.2.7	Entire Board	Entire Board	Entire Board
Pink Ring	3.3.2.8	N/A	N/A	N/A
Coverfilm Separations	3.3.2.9	Entire Board	Entire Board	Entire Board
Covercoat Requirements	3.3.2.10	Entire Board	Entire Board	Entire Board
Covercoat Coverage in Non-Flex Areas	3.3.2.10.1	Entire Board	Entire Board	Entire Board
Covercoat Cure and Adhesion	3.3.2.10.2	Entire Board	Entire Board	Entire Board
Covercoat Thickness	3.3.2.10.3	Entire Board	Entire Board	Entire Board
Solder Wicking/Plating Penetration	3.3.2.11	Entire Board	Entire Board	Entire Board
Stiffener	3.3.2.12	Entire Board	Entire Board	Entire Board
Plating and Coating Voids in the Hole	3.3.3	N/A	Entire Board	Entire Board
Marking	3.3.4	Entire Board	Entire Board	Entire Board
Solderability	3.3.5	A, B, C	A, B, C	A, B, C
Plating Adhesion	3.3.6	C	C	C

TEST	Requirement Paragraph	TYPE 1 & 5	TYPE 2	TYPE 3 & 4
Edge Board Contact, Junction of Gold Plate to Solder Finish	3.3.7	Only as Required	Only as Required	Only as Required
Lifted Lands	3.3.8	Entire Board	Entire Board	Entire Board
Workmanship	3.3.9	Entire Board	Entire Board	Entire Board
Dimensional Requirements	**3.4**			
Hole Size & Hole Pattern Accuracy	3.4.1	Entire Board	Entire Board	Entire Board
Annular Ring and Breakout (Internal)	3.4.2	N/A	N/A	Entire Board
Annular Ring (External)	3.4.3	Entire Board	Entire Board	Entire Board
Solderable Annular Ring (External)	3.4.3.1	Entire Board	Entire Board	Entire Board
Stiffener Access Hole	3.4.3.2	Entire Board	Entire Board	Entire Board
Bow and Twist (Individual Rigid or Stiffener Portions Only)	3.4.4	Entire Board	Entire Board	Entire Board
Conductor Definition	**3.5**			
Conductor Imperfections	3.5.1	Entire Board	Entire Board	Entire Board
Conductor Width Reduction	3.5.1.1	Entire Board	Entire Board	Entire Board
Conductor Thickness Reduction	3.5.1.2	Entire Board	Entire Board	Entire Board
Conductor Spacing	3.5.2	Entire Board	Entire Board	Entire Board
Conductor Surfaces	3.5.3	Entire Board	Entire Board	Entire Board
Nicks & Pinholes in Ground or Voltage Planes	3.5.3.1	Entire Board	Entire Board	Entire Board
Surface Mount Lands	3.5.3.2	Entire Board	Entire Board	Entire Board
Edge Connector Lands	3.5.3.3	Entire Board	Entire Board	Entire Board
Dewetting	3.5.3.4	Entire Board	Entire Board	Entire Board
Nonwetting	3.5.3.5	Entire Board	Entire Board	Entire Board
Final Finish Coverage	3.5.3.6	Entire Board	Entire Board	Entire Board
Conductor Edge Outgrowth	3.5.3.7	Entire Board	Entire Board	Entire Board
Physical Requirements	**3.6**			
Bending Flexibility	3.6.1	H	H	H
Flexible Endurance	3.6.2	H	H	H
Bond Strength (Unsupported Lands)	3.6.3	A, B	N/A	N/A
Bond Strength (Stiffener)	3.6.4	Only as Required	Only as Required	Only as Required
Structural Integrity	**3.7**			
Thermal Stress Testing	3.7.1	A, B	A, B	A, B
Requirements for Microsectioned Coupons	3.7.2	A, B	A, B	A, B
Laminate Integrity (Flexible)	3.7.3	A, B	A, B	A, B
Laminate Integrity (Rigid)	3.7.4	A, B	A, B	A, B
Etchback	3.7.5	N/A	N/A	A, B
Smear Removal	3.7.6	N/A	N/A	A, B
Negative Etchback	3.7.7	N/A	N/A	A, B
Plating Integrity	3.7.8	N/A	A, B	A, B
Plating Voids	3.7.9	N/A	A, B	A, B
Annular Ring (Internal)	3.7.10	N/A	N/A	A, B
Plating/Coating Thickness	3.7.11	A, B	A, B	A, B
Minimum Layer Copper Foil Thickness	3.7.12	A, B	A, B	A, B
Minimum Surface Conductor Thickness	3.7.13	A, B	A, B	A, B
Metal Cores	3.7.14	A, B	N/A	A, B
Dielectric Thickness	3.7.15	A, B	A, B	A, B
Resin Fill of Blind Buried Vias	3.7.16	A, B	A, B	A, B
Rework Simulation	**3.8**	**N/A**	**A, B**	**A, B**

TEST	Requirement Paragraph	TYPE 1 & 5	TYPE 2	TYPE 3 & 4
Electrical Requirements	**3.9**			
Dielectric Withstanding Voltage	3.9.1	E	E	E
Circuitry	3.9.2	D, H	D, H	D, H
Continuity	3.9.2.1	D, H	D, H	D, H
Isolation (Circuit Shorts)	3.9.2.2	D, H	D, H	D, H
Circuit/Plated-Through Hole Shorts to Metal Substrates	3.9.3	Only As Required	Only As Required	Only As Required
Insulation Resistance (As Received)	3.9.4	E	E	E
Environmental Requirements	**3.10**			
Moisture and Insulation Resistance	3.10.1	E	E	E
Thermal Shock	3.10.2	D	D	D
Cleanliness	3.10.3	Entire Board	Entire Board	Entire Board
Ionic (Resistivity of Solvent Extract)	3.10.3.1	Entire Board	Entire Board	Entire Board
Organic Contamination	3.10.4	Only as Required	Only as Required	Only as Required
Fungus Resistance	3.10.5	Only as Required	Only as Required	Only as Required
Special Requirements	**3.11**			
Outgassing	3.11.1	Only as Required	Only As Required	Only As Required
Impedance Testing	3.11.2	Only as Required	Only as Required	Only as Required
Repair	3.11.3	Only as Required	Only as Required	Only as Required
Circuit Repair	3.11.4	Only as Required	Only as Required	Only as Required
Rework	3.11.5	Only as Required	Only as Required	Only as Required
Coefficient of Thermal Expansion (CTE)	3.11.6	Only as Required	Only as Required	Only as Required

4.2 Acceptance Testing and Frequency Acceptance testing and frequency **shall** be performed as specified in Table 4-3 to the requirements of this specification and IPC-6011 using either quality conformance coupons and/or production boards. The quality conformance test coupons are described in IPC-2221 and indicate the purpose of the coupon and its frequency on a manufacturing panel. When ''Sample'' is indicated in Table 4-3, use the C=0 Sampling Plan specified in Table 4-2. The C=0 Sampling Plan provides greater or equal protection for the lot tolerance percent defective (LTPD) protection at the 0.010 ''consumer risk'' level. The Index Values at the top of each sample size column associates to the AQL level. For a lot to be accepted, all samples (shown in Table 4-2) **shall** conform to the requirements. A lot is ''withheld'' if one or more samples are non-conforming to the requirements. A ''withheld'' lot is not considered rejected until a review by the supplier and user is completed to assess the extent and seriousness of the non-conformance. Contact the American Society for Quality Control for more information on sampling plans.

4.2.1 Referee Tests Two additional microsection sets from the same panel may be prepared and evaluated for microsection defects that are considered to be isolated, random in nature, or caused by microsection preparation. For acceptance, both referee sets must be defect free.

4.3 Quality Conformance Testing Quality Conformance Testing **shall** be performed and consist of inspections specified in Table 4-4 in a facility which meets the requirements of IPC-QL-653, unless otherwise specified by the user. Class 3 testing results may be extended to reliability test and evaluation for Class 2.

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

Lot Size	AQL	CLASS 1			CLASS 2			CLASS 3			
		2.5	4.0	6.5	1.5	2.5	4.0	0.10	1.0	2.5	4.0
1-8		5	3	2	•	5	3	•	•	5	3
9-15		5	3	2	5	5	3	•	13	5	3
16-25		5	3	3	8	5	3	•	13	5	3
26-50		5	5	5	8	5	5	•	13	5	5
51-90		7	6	5	8	7	6	•	13	7	6
91-150		11	7	6	12	11	7	125	13	11	7
151-280		13	10	7	19	13	10	125	20	13	10
281-500		16	11	9	21	16	11	125	29	16	11
501-1.2k		19	15	11	27	19	15	125	34	19	15
1.2k-3.2k		23	18	13	35	23	18	192	42	23	18
3.2k-10.0k		29	22	15	38	29	22	294	50	29	22
10.0k-35.0k		35	29	15	46	35	29	345	60	35	29

• Denotes inspect entire lot.

Table 4-3 Acceptance Testing and Frequency

INSPECTION	REQUIREMENT	PRODUCTION FLEXIBLE PRINTED WIRING (BOARD)	TEST COUPON BY BOARD	CLASS 1	CLASS 2	CLASS 3	REMARKS
Material	3.2.1 - 3.2.13			Manufacturer's Certification			Verifiable Certificate of Compliance or SPC Program
VISUAL							
Edges, Rigid Section	3.3.1.1	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Edges, Flex Section	3.3.1.3	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Transition Zone, Rigid Area to Flex Area	3.3.1.4	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Construction Imperfections	3.3.2	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Haloing	3.3.2.1	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Measling and Crazing	3.3.2.2	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Foreign Inclusions	3.3.2.3	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Weave Exposure	3.3.2.4	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Scratches, Dents and Tool Marks	3.3.2.5	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Surface Microvoids	3.3.2.6	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Color Variations In Bond Treatment	3.3.2.7	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Pink Ring	3.3.2.8	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	Applicable to Types 3 & 4 Only
Coverfilm Separations	3.3.2.9	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Covercoat Coverage In Non-Flex Areas	3.3.2.10.1	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	

INSPECTION	REQUIREMENT	PRODUCTION FLEXIBLE PRINTED WIRING (BOARD)	TEST COUPON BY BOARD	CLASS 1	CLASS 2	CLASS 3	REMARKS
Covercoat Cure and Adhesion	3.3.2.10.2	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Solder Wicking and Plating Penetration	3.3.2.11	X		Sample (4.0)	Sample (2.5)	Sample (2.5)	
Plating and Coating Voids in Holes	3.3.3	X		Sample (4.0)	Sample (2.5)	Sample (1.0)	Applicable to Types 2,3 & 4 Only
Marking and Traceability	3.3.4	X	(Retained Coupons)	Sample (6.5)	Sample (4.0)	Sample (4.0)	
Solderability: Surface / Hole	3.3.5		C and A	Sample (4.0)	Sample (2.5)	Sample (1.0)	
Plating Adhesion	3.3.6	X					
Edge Board Contact, Junction of Gold Plate to Solder Finish	3.3.7	X		Sample (4.0)	Sample (2.5)	Sample (1.0)	
Lifted Lands	3.3.8	X		Sample (4.0)	Sample (2.5)	Sample (1.0)	
Workmanship	3.3.9						
DIMENSIONAL REQUIREMENTS							
Dimensional: Flexible Printed Wiring	3.4	X		Sample (6.5)	Sample (4.0)	Sample (4.0)	
Hole Size and Hole Pattern Accuracy	3.4.1	X		Sample (6.5)	Sample (4.0)	Sample (4.0)	
Annular Ring and Breakout (Internal)	3.4.2		A or B	Not Required	Sample (1.5)	Sample (1.0)	
Annular Ring (External)	3.4.3.1	X		Sample (6.5)	Sample (4.0)	Sample (4.0)	
Solderable Annular Ring (External)	3.4.3.2	X		Sample (6.5)	Sample (4.0)	Sample (4.0)	
Bow and Twist (Individual Board or Stiffener Portion Only)	3.4.4	X		Sample (6.5)	Sample (4.0)	Sample (4.0)	
CONDUCTOR DEFINITION							
Conductor Imperfections	3.5.1	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
Conductor Width Reduction	3.5.1.1	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
Conductor Thickness Reduction	3.5.1.2	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
Conductor Spacing	3.5.2	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
CONDUCTOR SURFACES							
Nicks or Pinholes in Ground or Voltage Planes	3.5.3.1	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
Surface Mount Lands	3.5.3.2	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	

INSPECTION	REQUIREMENT	PRODUCTION FLEXIBLE PRINTED WIRING (BOARD)	TEST COUPON BY BOARD	CLASS 1	CLASS 2	CLASS 3	REMARKS
Edge Connector Lands	3.5.3.3	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
Dewetting / Nonwetting	3.5.3.4 3.5.3.5 3.5.3.6	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
Conductor Edge Outgrowth	3.5.3.7	X		Sample (6.5)	Sample (4.0)	Sample (2.5)	
STRUCTURAL INTEGRITY (TYPE 3 AND TYPE 4)							
Thermal Stress Testing	3.7.1		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Requirements for Micosectioned Coupons	3.7.2		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Laminated Integrity (Flexible)	3.7.3		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Laminated Integrity (Rigid)	3.7.4		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Etchback (Type 3 and Type 4 Only)	3.7.5		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Smear Removal (Type 3 and Type 4 Only)	3.7.6		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Negative Etchback	3.7.7		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Plating Integrity	3.7.8		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Plating Voids	3.7.9		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Annular Ring (Internal)	3.7.10		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Plating/Coating Thickness	3.7.11		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Minimum Layer/ Copper Foil Thickness	3.7.12		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Minimum Surface Conductor Thickness	3.7.13		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Metal Cores	3.7.14		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Dielectric Thickness	3.7.15		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Resin Fill of Blind and Buried Vias	3.7.16		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
STRUCTURAL INTEGRITY (TYPE 2)							
Thermal Stress Testing	3.7.1		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Requirements for Microsectioned Coupons	3.7.2		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Laminate Integrity (Flexible)	3.7.3		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Laminate Integrity (Rigid)	3.7.4		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Plating Integrity	3.7.8		A or B	Sample (2.5)	Sample (4.0)	Sample (1.0)	
Plating Voids	3.7.9		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	

INSPECTION	REQUIREMENT	PRODUCTION FLEXIBLE PRINTED WIRING (BOARD)	TEST COUPON BY BOARD	CLASS 1	CLASS 2	CLASS 3	REMARKS
Plating/Coating Thickness	3.7.11		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Minimum Surface Conductor Thickness	3.7.13		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
Dielectric Thickness	3.7.15		A or B	Sample (2.5)	Sample (1.5)	Sample (1.0)	
ELECTRICAL REQUIREMENTS							
Circuit Continuity	3.9.2.1	X		Sample (2.5) Ref Note 2	100% Ref Note 2	100% Ref Note 2	
Isolation (Circuit Shorts)	3.9.2.2	X		Sample (2.5) Ref Note 2	100% Ref Note 2	100% Ref Note 2	
Circuits/ Plated-Through Hole Shorts to Metal Substrates	3.9.3	X		Sample (2.5)	100%	100%	When Applicable
Insulation Resistance (As Received)	3.9.4	X		Sample (2.5)	100%	100%	When Applicable
ENVIRONMENTAL REQUIREMENTS							
Moisture Insulation Resistance	3.10.1			Only Applicable When Imposed by Contract			
Thermal Shock	3.10.2						
Cleanliness	3.10.3						
Ionic (Resistivity of Solvent Extract)	3.10.3.1						
Organic Contamination	3.10.4						
Fungus Resistance	3.10.5						
SPECIAL REQUIREMENTS							
Dielectric Withstand Voltage	3.9.1			Only Applicable When Imposed by Contract			
Outgassing	3.11.1						
Impedance Testing	3.11.2						
Repair	3.11.3						
Circuit Repair	3.11.4						
Rework	3.11.5						
Coefficient of Thermal Expansion (CTE)	3.11.6						

NOTES:
1. Numbers in parentheses are the AQL level.
2. For Type 1 and Type 2 flexible printed wiring, visual or AQL inspection may be used in lieu of electrical testing.

Table 4-4 Quality Conformance Testing

Inspection	Requirement and Method Section	Test Coupon		Test Frequency		
		Type 1, 5	Type 2 - 4	Class 1	Class 2	Class 3
Rework Simulation	3.8	–	B	As required	Two coupons per QTR	Two coupons per month
Bond Strength (Unsupported Lands)	3.6.3	B	As required	As required	Two coupons per QTR	Two coupons per month
Bond Strength (Stiffener)	3.6.4	Board	Board	As required	As required	As required
Dielectric Withstanding Voltage	3.9.1	E	E	As required	Two coupons per QTR	Two coupons per month
Moisture and Insulation Resistance	3.10.1	E	E	Maintain electrical function	Two coupons per QTR	Two coupons per month

4.3.1 Coupon Selection The fabricator **shall** select two quality conformance test coupons of the most complex construction of each material slash sheet type processed during the inspection period from lots that have passed quality conformance inspection.

5 NOTES

5.1 Ordering Data The procurement documentation should specify the following:

A. Title, numbers issue, revision letter, and date of current applicable procurement document.

B. Specific exceptions, variations, additions, or conditions to this specification that are required by the user.

C. Part identification and marking instructions.

D. Information for preparation for delivery, if applicable.

E. Special tests required and frequency.

5.2 Superseded Specifications This specification supersedes and replaces IPC-FC-250 and IPC-RF-245.

APPENDIX A

Appendix A presents the performance requirements of IPC-6013 in an abbreviated form and alphabetical order. Special conditions, lengthy requirements, and tutorial information may be shortened or partially omitted in this appendix. See the referenced paragraph in this appendix for the full specification requirements.

Table A-1

Characteristic Inspection	Requirements			Requirement Paragraph
	Class 1	Class 2	Class 3	
Annular Ring (External)	Plated-through holes: 180° breakout	Plated-through holes: 90° breakout Conductor junction not < 50 µm	Plated-through holes: Min. external ring not < 50 µm	3.4.3
	Unsupported holes: No breakout	Unsupported holes: No breakout	Unsupported holes: Min. annular ring not < 150 µm	
Annular Ring (Internal)	Breakout allowed per Fig 3-5	Hole to pad tangency	0.025 mm	3.7.10
Annular Ring and Breakout (Internal)	Microsection to verify correlation and a calibration standard made for probing technique			3.4.2
Bending Flexibility	As specified in appropriate document/drawing			3.6.1
Bond Strength (Stiffener)	Peel strength between the flexible printed wiring and the stiffener > 1.4 kg per 25 mm			3.6.4
Bond Strength (Unsupported Lands)	As per IPC-TM-650, Method 2.4.20, unsupported land **shall** withstand 1.86 kg pull or 35 kg/cm^2, whichever is less, after subjection to five cycles of soldering and unsoldering			3.6.3
Bow & Twist (Individual Rigid or Stiffener Portion Only)	Surface applications: 0.75% bow & twist (or determined by user and supplier)			3.4.4
	All other applications: 1.5% bow & twist (or determined by user and supplier)			
Circuit Repair	No more than two repairs for each 0.09 m^2; no impedance or min electrical spacing req violated			3.11.4
Circuitry	Testing conducted in accordance with IPC-ET-652			3.9.2
Circuits/Plated-Through Hole Shorts to Metal Substrates	Metal core flexible printed board will withstand 500 volts DC between circuitry/plated-through holes and metal core substrates w/o flashover or dielectric breakdown			3.9.3
Cleanliness	Type 4 & Type 5 flexibles **shall** be tested and evaluated in accordance with 3.10.3.1			3.10.3
Coefficient of Thermal Expansion	If have metal cores/reinforcements with a req to constrain thermal expansion in planar directions, CTE **shall** be within ± 2 ppm/°C for CTE & temp range spec on master drawing; testing w/ strain gauge method, according to IPC-TM-650, Method 2.4.41.2 unless otherwise agreed by user and supplier			3.11.6
Color Variations in Bond Enhancement Treatment	Mottled appearance / color variation accept; Random missing areas of treatment **shall** not be > 10%			3.3.2.7
Conductor Definition	Meet visual & dimension req., pattern & thickness as specified in procurement documentation			3.5
Conductor Edge Outgrowth	No outgrowth on edges of conductors that have been solder coated or tin-lead plated and fused when tested according to IPC-TM-650, Method 2.4.1			3.5.3.7
Conductor Imperfections	Cross-sectional area of conductor not reduced > 30% of min value	Cross-sectional area of conductor not reduced > 20% of min value; total defect not > 10% of conductor or 13 mm (whichever is less)		3.5.1
	No cracks, splits or tears			
Conductor Spacing	Minimum conductor spacing may be reduced an additional 30% due to conductor edge roughness, spikes, etc.		Min. conductor spacing may be reduced < 20%	3.5.2
Conductor Surfaces				3.5.3
Conductor Thickness Reduction	Reduction of conductor thickness not > 30% of minimum	Reduction of conductor thickness not > 20% of minimum		3.5.1.2

Characteristic Inspection	Requirements			Requirement Paragraph
	Class 1	Class 2	Class 3	
Conductor Width Reduction	Reduction of conductor width not > 30% of minimum	Reduction of conductor width not > 20% of minimum		3.5.1.1
Construction Imperfections	Measling, crazing, blistering, delamination, and haloing **shall** be in accordance with IPC-A-600			3.3.2
Continuity	No circuits with resistance > the values in IPC-ET-652; current passed through for evaluation will not be > values in IPC-2221 for smallest conductor of circuit			3.9.2.1
Covercoat Coverage in Non-Flex Areas	Conductors not exposed where covercoat required			3.3.2.10.1
	Blistering does not bridge between conductors	Two per side, max size 0.25 mm in longest dim, spacing between conductors not reduced to < 25%		
Covercoat Cure and Adhesion	Max % loss allowed (µm) Copper (10 µm) Gold or Nickel (25 µm) Base Laminate (10 µm) Melting Metals (50 µm)	Max % loss allowed (µm) Copper (5 µm) Gold or Nickel (10 µm) Base Laminate (5 µm) Melting Metals (25 µm)	Max % loss allowed (µm) Copper (0 µm) Gold or Nickel (5 µm) Base Laminate (0 µm) Melting Metals (10 µm)	3.3.2.10.2
Covercoat Requirements	See 3.3.2.10.1 thru 3.3.2.10.3			3.3.2.10
Covercoat Thickness	Not measured unless required by procurement documentation			3.3.2.10.3
Coverfilm Separations	Uniform coverfilm, free of separations. Non-lamination good if according to 3.3.2.3, not > 2.5 mm x 2.5 mm, not > 3 in 25 mm x 25 mm space, not > 25% of spacing between conductors			3.3.2.9
Dewetting	Solder connection: 15%	Solder connection: 5%		3.5.3.4
	Conductors and planes are permitted			
Dielectric Thickness	90 µm min dielectric spacing unless otherwise specified in procurement documentation			3.7.15
Dielectric Withstand Voltage	See Table 3-12; the dielectric withstanding voltage test **shall** be performed in accordance with IPC-TM-650, Method 2.5.7			3.9.1
Dimensional Requirements	As specified in procurement documentation			3.4
Edge Board Contact, Junction of Gold Plate to Solder Finish	Copper: 2.5 mm	Copper: 1.25 mm	Copper: 0.8 mm	3.3.7
	Gold: 2.5 mm	Gold: 1.25 mm	Gold: 0.8 mm	
Edge Connector Lands	No cuts or scratches that expose nickel or copper; Pits, dents, or depressions accept if not exceed 0.15 mm in longest dimension with no more than 3 per land, and not appear in > 30% of lands			3.5.3.3
Edges, Flexible Section	Free of burrs, nicks, delamination, or tears in excess of that allowed in the procurement documentation (except if a result of tie-in tabs to facilitate circuit removal)			3.3.1.2
Edges, Ridged Section	Accept if penetration not > 50% of distance from edge to nearest conductor or 2.5 mm, whichever is less			3.3.1.1
Electrical	Voltage: No requirements	Voltage: 500Vdc (+15, -0)	Voltage: 1000 Vdc (+25, -0)	3.9
	Time: No requirements	Time: 30 sec (+3, -0)	Time: 30 sec (+3, -0)	
Environmental				3.10
Etchback (Type 3 & Type 4 Only)	Between 0.003 mm (copper exposed) and 0.08 mm (maximum material removed)		3.7.5	
Final Finish Coverage	Exposed copper on area not to be soldered allowed up to 5%		Exposed copper on area not to be soldered allowed up to 1%	3.5.3.6
	Shall meet requirements of J-STD-003			
Flexible Endurance	As specified in appropriate document/drawing, according to IPC-TM-650, Method 2.4.3			3.6.2
Foreign Inclusions	Translucent particles accept; others only if distance to nearest conductor is > 0.125 mm			3.3.2.3
Fungus Resistance	No fungus growth according to IPC-TM-650, Method 2.6.1			3.10.5
Haloing	Does not penetrate more than 2.5 mm or 50% of distance to closest conductor, whichever is less.			3.3.2.1

Characteristic Inspection	Requirements			Requirement Paragraph
	Class 1	Class 2	Class 3	
Hole Size and Hole Pattern Accuracy	As specified in procurement documentation			3.4.1
Impedance Testing	As specified in procurement documentation; TDR used for electrical testing, but for large impedance tolerances (± 10%), mechanical measurements from a microsection utilizing a special test coupon			3.11.2
Insulation Resistance (As Received)	As received: Maintain electrical function	As received: 500 megohms		3.9.4
	After exposure to moisture: Maintain electrical function	After exposure to moisture: 100 megohms	After exposure to moisture: 500 megohms	
Ionic (Resistivity of Solvent Extract)	Testing in accordance to IPC-TM-650, Method 2.3.25, with contamination level of < 1.56 µg/cm^2 of sodium chloride			3.10.3.1
Isolation (Circuit Shorts)	Isolation resistance between conductors **shall** meet values established in IPC-ET-652; 200volt min for manual testing for at least five seconds; for automated tests, if min voltage not specified - 40 volts min			3.9.2.2
Laminate Integrity (Flexible)	No laminate voids in Zone B (see Fig 3-11) in excess of 0.50 mm			3.7.3
Laminate Integrity (Rigid)	See section 3.7.4 and Figure 3-11			3.7.4
Lifted Lands	No lifted lands			3.3.8
Marking	Conductive marking must be compatible with materials, and not reduce electrical spacing requirements			3.3.4
Material	Manufacturer's Certification			
Measling and Crazing	Measling and crazing **shall** be acceptable			3.3.2.2
Metal Cores	Wicking, radial cracks, lateral spacing, or voids in the hole-fill insulation material **shall** not reduce electrical spacing between adjacent conductive surfaces to < 0.100mm			3.7.14
Minimum Layer/Copper Foil Thickness	If not specified in procurement documentation, see Table 3-10			3.7.12
Minimum Surface Conductor Thickness	If not specified in procurement documentation, see Table 3-11			3.7.13
Moisture and Insulation Resistance	No measling, blistering or delamination in excess of that allowed in 3.3.2; insulation resistance meet requirements of Table 3-13; moisture & insulation resistance testing according to IPC-TM-650			3.10.1
Negative Etchback	Not to exceed 25 µm if etchback specified on procurement documentation	Not to exceed 25 µm if etchback specified on procurement documentation	Not to exceed 13 µm if etchback specified on procurement documentation	3.7.7
Nicks and Pinholes in Ground or Voltage Planes	Maximum size 1.5 mm	Maximum size 1.0 mm		3.5.3.1
Nonwetting	For tin, tin/lead reflowed, or solder coated surfaces, only allowed outside minimum solderable area or annular ring requirement			3.5.3.5
Organic Contamination	Tested according to IPC-TM-650, Method 2.3.38 or 2.3.39, w/ no positive id of organic contamination			3.10.4
Outgassing	Testing in accordance to procurement documentation; not resulting in a weight loss of more than 0.1%			3.11.1
Physical Requirements				3.6
Pink Ring	Acceptable			3.3.2.8
Plating Adhesion	No portion of protective plating or conductor pattern foil **shall** be removed. Testing in accordance with IPC-TM-650, Method 2.4.1			3.3.6
Plating/Coating Thickness	**Shall** meet requirements of Table 3-1 or as specified in procurement documentation, isolated areas of reduced copper thickness **shall** be measured and evaluated to the copper plating void rejection criteria specified in 3.3.3			3.7.11

Characteristic Inspection	Requirements			Requirement Paragraph
	Class 1	Class 2	Class 3	
Plating and Coating Voids in the Hole	Copper: 3 voids per hole in < 10% of holes	Copper: 1 void per hole in < 5% of holes	Copper: none	3.3.3
	Finish Coating: 5 voids per hole in < 15% of holes	Finish Coating: 3 voids per hole in < 5% of holes	Finished Coating: 1 void per hole in < 5% of holes	
Plating Integrity		No separation of layers (except as noted in Table 3-8)		3.7.8
	Areas of contamination or inclusions not to exceed 5% of each side of the interconnection or occur in the interface of the copper cladding on the core and the copper plating in the hole wall			
Plating Voids	Meet requirements established in Table 3-8	No more than 1 void per specimen, regardless of length or size		3.7.9
Repair	As agreed upon by user and supplier			3.11.3
Requirements for Microsectioned Coupons	See table 3-8			3.7.2
Resin Fill of Blind and Buried Vias	No fill requirement			3.7.16
Rework	Does not affect functional integrity of board			3.11.5
Scratches, Dents, and Tool Marks	Not bridge conductors, expose fibers > allowed in 3.3.2.3 and 3.3.2.4, and do not reduce dielectric spacing below minimum			3.3.2.5
Smear Removal (Type 3 & Type 4 Only)	**Shall** be sufficient to completely remove resin from surface of the conductor interface (see Fig 3-13)			3.7.6
Solder Wicking/Plating Migration	As agreed upon between user and supplier	0.5 mm maximum	0.3 mm maximum	3.3.2.11
Solderability	Solderability testing and accelerated aging will be in accordance to J-STD-003			3.3.5
Solderable Annular Ring (External)	Meet requirements of 3.4.3			3.4.3.1
Special	As specified in procurement documentation			3.11
Stiffener	Requirements agreed upon between user and supplier			3.3.2.12
Stiffener Access Hole	**Shall** not reduce external annular ring requirements below that specified in 3.4.3			3.4.3.2
Structural Integrity	**Shall** meet structural integrity requirements for thermally stressed (after solder float) evaluation coupons specified in 3.7.2			3.7
Surface Microvoids	Not exceed 0.8 mm in longest dimension, bridge conductors, nor exceed 5% of printed area			3.3.2.6
Surface Mount Lands	Defects along edge of land not > 30%; internal defects not > 20%	Defects along edge of land not > 20%; internal defects not > 10%		3.5.3.2
Thermal Shock	Testing/evaluation according to IPC-TM-650, Method 2.6.7.2, with temp range between -65°C & 125°C			3.10.2
Thermal Stress Testing	Specimens conditioned by baking at 120°C-150°C for six hours, depending on thickness and according to IPC-TM-650, Method 2.6.8. After microsectioning, plated-through holes **shall** be examined for foil and plating at 100X ± 5%. Referee examinations made at 200X (±5%.			3.7.1
Transition Zone, Rigid Area to Flexible Area	Imperfections in excess of that allowed **shall** be agreed upon between the fabricator and user, or as so stated on the procurement documentation.			3.3.1.3
Visual	Finished product **shall** be examined, be of uniform quality, and conform to 3.3.1 through 3.3.9			3.3
Weave Exposure	Acceptable if does not reduce conductor spacing below minimum			3.3.2.4
Workmanship	**Shall** be free of defects and of uniform quality - no visual of dirt, foreign matter, oil, fingerprints			3.3.9

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