

Conformance to IPC-4101

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Benefits of 4101

- Industry Consensus Document Written By:
 - Laminators
 - Government
 - OEM's
 - PWB Manufacturers
- Statistical Techniques Utilized
- Now in a forum for Rapid Amendment if necessary.

IPC-4101 - Class 101

- IPC-4101 was created at the request of DSCC in order to *replace* MIL-S-13949 as a new revision.
- Document was written over three years with support from the Laminators, DSCC, OEM's & PWB Manufacturers.
- The Material Requirements of IPC-4101 are the same or more stringent than MIL-S-13949.

IPC-4101 - Class 101

- The “Default” Frequency of testing ranges from identical to slightly reduced from MIL-S-13949H.
- The Frequency of Testing can be modified in a Laminators Quality Plan by using statistical techniques highlighted in IPC-PC-90.
- IPC-4101 is an “All Metric” Document.

IPC-4101 - Class 101

- Political Changes in the DSCC Structure caused various organizations within DSCC to “not want” industry specifications within their structure.
- Political Pressure by the IPC at high levels caused cancellation notice to appear as currently stated.
- DSCC could change its mind before the November 30 cancellation date.
- IPC-4101 is not currently scheduled by DSCC as a replacement for MIL-S-13949.

MIL-S-13949; Cancelled without Replacement

- Treat MIL-S-13949 as though it never existed.
- No direct path to “grandfather” current MIL-S-13949 drawing requirement callouts.
- Any specification can be used for procuring materials for MIL SPEC projects (free-for-all).
- Cannot be used for certification of Laminates & Prepregs.
- No QPL Program.

IPC-4101 vs. MIL-S-13949

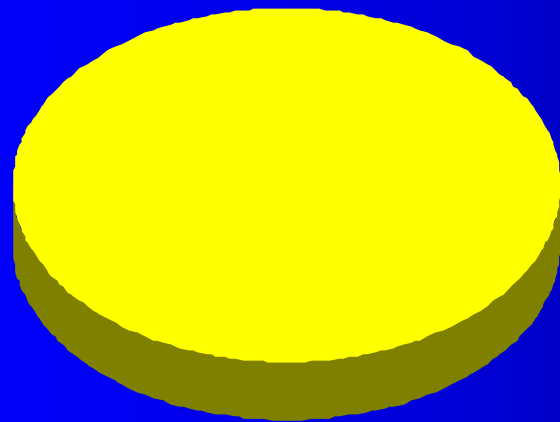
- Test Methods Identical to MIL-S-13949H
 - All found in IPC-TM-650
 - Exceptions:
 - Q Resonance Eliminated for Qualification
 - Flame Testing Now UL 94 (Tougher Requirement)

IPC-4101 vs. MIL-S-13949

- Specification Sheets (Slash Sheets) are broken into families.
- Room Saved in Families for Additions.
- 30 Specification Sheets (13 New).
- Laminate & Prepreg on Same Specification Sheet.

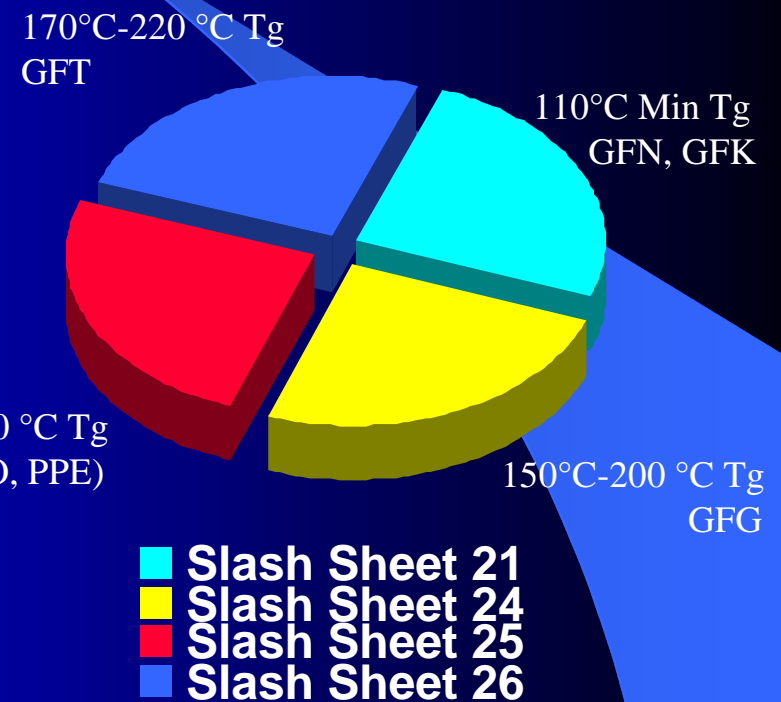
IPC-4101 vs. MIL-S-13949

Epoxy Specification Sheets



■ Slash Sheet 4

MIL-S-13949



■ Slash Sheet 21
■ Slash Sheet 24
■ Slash Sheet 25
■ Slash Sheet 26

IPC-4101

IPC-4101 Test Frequency (Laminate)

Table 5 Reference Information and Test Frequency of Laminate

This table is applicable for Qualification Testing and where a documented Manufacturers Quality System is absent for Conformance Testing.

Tests	Requirement Paragraph	Test ¹ Method	Qualification Testing	Conformance Testing	Frequency	Samples per Sheet
General						
Visuals	3.8.3.1	2.1.5	✓	✓	Audit ²	
Surface Finishes	3.8.3.1.1 3.8.3.1.5	2.1.5 2.1.9	✓		Audit ²	
Surface/Sub-Surface Imperfections	3.8.3.1.6		✓	✓	Lot	3
Dimensional ⁹	3.8.4	2.2.19.1	✓	✓	Audit ²	-
Bow/Twist	3.8.4.3	2.4.22.1	✓	✓	Lot	1
Physical						
Peel Strength After Thermal Stress	3.9.1.1.1	2.4.8	✓	✓	Lot	4 ⁵
Peel Strength At Elevated Temperature ⁴	3.9.1.1.2	2.4.8 2.4.8.2 2.4.8.3	✓	✓	3 Mon.	4 ⁵
Peel Strength After/Exposure to ^{3,4} Process Solutions	3.9.1.1.3	2.4.8	✓	✓	3 Mon.	4 ⁵
Dimensional Stability ¹²	3.9.1.2	2.4.39	✓	✓	1 Mon.	3
Flexural Strength	3.9.1.3	2.4.4	✓	✓	12 Mon.	6 ⁷
Flexural Strength at Elevated Temperatures ²	3.9.1.4	2.4.4.1	✓	✓	3 Mon.	3 ⁸
Chemical						
Flammability ¹⁰	3.10.1.1	2.3.10	✓	✓	1 Mon.	3
Thermal Stress Etched	3.10.1.2	2.4.13.1	✓	✓	Lot	2
Thermal Stress Unetched	3.10.1.2	2.4.13.1	✓	✓	Lot	2
Solderability	3.10.1.3	J STD-009 Edge Dip	✓	✓	3 Mon.	3
Chemical Resistance ³	3.10.1.4	2.3.4.3	✓	✓	Lot	1
Metal Surface Cleanability ³	3.10.1.5	2.3.1.1	✓	✓	Lot	1
T _g ³	3.10.1.6	2.4.24 2.4.25	✓	✓	Lot	1
Delta T _g ³	3.10.1.7	2.4.25		✓	Lot	1
Ave. X/Y CTE ³	3.10.1.8	2.4.41 2.4.41.1	✓		Lot	1
Electrical						
Permittivity ⁴	3.11.1.1	2.5.5.2, 2.5.5.3	✓	✓	1 Mon.	3

IPC-4101 Test Frequency (Laminate)

Tests	Requirement Paragraph	Test ¹ Method	Qualification Testing	Conformance Testing	Frequency	Samples per Sheet
Loss Tangent ²	3.11.1.2	2.5.5.2, 2.5.5.3	✓	✓	1 Mon	3
Volume Resistivity	3.11.1.3	2.5.17.1	✓	✓	12 Mon	6
Surface Resistivity	3.11.1.4	2.5.17.1	✓	✓	12 Mon	6
Arc Resistance	3.11.1.5	2.5.1	✓	✓	12 Mon	3
Dielectric Breakdown	3.11.1.6	2.5.6	✓	✓	3 Mon	3 ²
Electric Strength	3.11.1.7	2.5.6.2	✓	✓	3 Mon	3
Environmental						
Moisture Absorption	3.12.1.1	2.6.2.1	✓	✓	3 Mon	4
Fungus ³	3.12.1.2	2.6.1	✓			1
Pressure Vessel ^{3,4}	3.12.1.3	2.6.16		✓	Lot	3

¹ All methods are from IPC-TM-650 unless otherwise noted.

² Table for audit of visuals and dimensionals shown below

Lot Size	Sample Size	Acceptance Number
2 to 50	5	0
51 to 90	7	0
91 to 150	11	0
151 to 280	13	0
281 to 500	16	0
501 to 1,200	19	0
1,201 to 3,200	23	0
3,201 to 10,000	29	0

IPC-4101 Test Frequency (Prepreg)

Table 6 Reference Information and Test Frequency of Prepreg

This table is applicable for Qualification Testing and where a documented Manufacturers Quality System is absent for Conformance Testing.

Tests	Requirement Paragraph	Test ¹ Method	Qualification Testing	Conformance Testing	Frequency	Samples per Sheet
General						
Visuals	3.8.3.2	2.1.5	✓	✓	Lot	1
Dimensions	3.8.4		✓	✓	Audit ^d	
Physical						
Resin Content Method ²	3.9.2.1					
Resin Content Percent						
By Treated Weight ²	3.9.2.1.1	2.3.16.1		✓	Lot	1
By Burn-Off ²	3.9.2.1.2	2.3.16	✓	✓	Lot	1
Treated Weight Total ²	3.9.2.1.3	2.3.16.2		✓	Lot	
Flow Parameter Method ³	3.9.2.2					
Resin Flow Percent ³	3.9.2.2.1	2.3.17	✓	✓	Lot	1
Scaled Flow Thickness ³	3.9.2.2.2	2.4.38	✓	✓	Lot	1
No Flow	3.9.2.2.3	AABUS ⁷	✓	✓	Lot	1
Rheological Flow	3.9.2.2.4	AABUS ⁷		✓	Lot	1
Delta H	3.9.2.2.5	AABUS ⁷		✓	Lot	1
Gel Time ⁴	3.9.2.2.6	2.3.18	✓	✓	Lot	1
% Cure	3.9.2.2.7	AABUS ⁷		✓	Lot	1
Volatile Content ⁴	3.9.2.2.8	2.3.19	✓	✓	Lot	1
Chemical						
Flammability ^{8,9}	3.10.2.1	2.3.10	✓	✓	1 Mon	3
Chemical Resistance ^{4,9}	3.10.2.2	2.3.4.2		✓	Lot	
Presence of Dicy ⁴	3.10.2.3	2.1.10	✓	✓	Lot	
Electrical						
Permittivity ^{5,9}	3.11.2.1	2.5.5.2 2.5.5.3	✓		1 Mon	3
Loss Tangent ^{5,9}	3.11.2.2	2.5.5.2 2.5.5.3	✓		1 Mon	3
Electric Strength ⁹	3.11.2.3	2.5.6.2	✓	✓	3 Mon	3
Environmental						
Fungus ^{9,10}	3.12.2.1	2.6.1	✓			1

How Much is a Lot

- Laminate

- Material Covered by a Single Specification Sheet.
- 200 Sheets or 1 Press Load Whichever is Greater.

- Prepreg

- One Master Roll.
- Splices OK.
- Inspected at Beginning and End (Minimum).

All Materials Must be Qualified

- Qualification:

- Must be conducted at an IPC-QL-653 Lab.
- Materials already on MIL-S-13949 QPL are already “grandfathered” into IPC-4101 (not currently specified but will be included in next amendment).
- Qualification data must be available for review.
- Qualification of thin and thick changed.

Definition of Thin versus Thick Laminates

- New Threshold Thickness:
 - Thin is less than 0.031”.
 - Qualification testing of any laminate less than 0.010” qualifies all thin materials.
 - Thick is 0.031” and greater.
 - Qualification testing of any laminate more than 0.031” qualifies all thick material.
 - MIL-S-13949H had cut-off at 0.020”.

Inspection Frequency (Laminate)

- Laminate Testing

- 1 Sheet per “Lot” when “Lot” is specified by Inspection Table.
- Visual Sampling Plan Defined on Table.
- Monthly, Quarterly, Yearly
 - ≤ 200 Sheets -- 1 Sample
 - 201 - 1,000 Sheets -- 2 Samples
 - 1,001 - 10,000 Sheets -- 3 Samples
 - $\geq 10,000$ Sheets -- 4 Samples

Inspection Frequency (Prepreg)

- Prepreg

- Minimum Beginning & End of Master Roll when “Lot” is specified by Table.
- Monthly, Quarterly, Yearly
 - ≤ 730 m -- 0 Samples
 - 731-20,100 m -- 2 Samples
 - $\geq 20,100$ m -- 3 Samples

When Can I Stop Testing

- IPC-4101 Gives Flexibility of using Statistical Methods for Compliance Demonstration.
- But I Never Fail The Test.
 - This is NOT Process Control, and will not relieve a vendor of testing requirements.
 - A Quality Plan using Statistical Methods complying with IPC-PC-90 is the ONLY reason to reduce testing.

The New (maybe) Auditors

- Customer Audits

- Large Customers Will Audit Compliance.
- Demonstration of SPC decision making process and Implementation of IPC-PC-90 will be necessary.

- Third Party Auditors

- ISO Auditors
- BSI.
 - Setting up auditing program to IPC-4101

IPC-4101 Compliance Using SPC by IPC-PC-90

- One Must Demonstrate Compliance to IPC-4101 by any Combination of the Following:
 - Quality Conformance Evaluations
 - End Product Control
 - In-Process Product Control
 - Process Parameter Control

IPC-4101 Compliance Using SPC by IPC-PC-90

- Quality Conformance Evaluations
 - Testing of each Product Lot (Group A)
 - Periodic Testing (Groups B & C)
 - Defined Clearly in the Specification

IPC-4101 Compliance Using SPC by IPC-PC-90

- End Product Parameters
 - Audit Criteria.
 - Must have Plan.
 - Demonstrate Objective Evidence.
 - Ranking of parameters by Level of Importance.
 - Reasons for selecting parameters.

IPC-4101 Compliance Using SPC by IPC-PC-90

● In-Process / Process Parameters

- Audit Criteria.
 - Must have Plan.
 - Demonstrate Objective Evidence.
- Ranking of parameters by Level of Importance.
- Reasons for selecting parameters.
- Method for Determining Cause / Effect Relationships to End Product / Process Parameters.
- Decision Criteria (i.e. Level of Confidence).
- Method for Determining Reproducibility.
- Provisions for Complying with Published Specs.

IPC-4101 Rewards Consistent Dimensional Stability

- IPC-4101 Paragraph 3.9.1.2:

- The test is the standard IPC-TM-650 Method 2.4.39.
- Instead of a target of “zero” movement, the supplier must provide the nominal.
- Each construction will have a statistically based nominal.
- The customer will choose the tolerance around the stated nominal movement:

- Range A +/- 3.0 microns per cm (0.0003”/inch)
- Range B +/- 5.0 microns per cm (0.0005”/inch)
- Range C +/- 7.5 microns per cm (0.00075”/inch)

IPC-4101 Designates a New Part Number

- Classification (Laminates):

- MIL “Part Number” replaced with IPC-4101 version.
- As an example:

- L210140H1/H1CB

- L21 Laminates Specification Sheet # 21
- 0140 Nominal Thickness of 0.0140”
- H1/H1 Copper Configuration
- C Thickness Tolerance Class C (as a core)
- B Surface Quality Class B

Flexibility in Laminate Thickness for Ordering Purposes

- Laminate Thickness - Have it your way:

- Measured as a Core without Copper Foil

- Class A Old MIL Class 1
 - Class B Old MIL Class 2
 - Class C Old MIL Class 3
 - Class D Old MIL Class 4

- Measured as an Overall with Copper Foil

- Class K Old MIL Class 1
 - Class L Old MIL Class 2
 - Class M Old MIL Class 3

Defines the Toughest Class of Pits and Dents

- IPC-4101 Class D:

- As inspected with 20/20 vision, point count of zero.
- No pits or dents greater than 0.005”.
- No epoxy spots.
- By comparison, MIL B specifies a maximum point count of 5 and no pits or dents greater than 0.015”.

IPC-4101 Designates a New Part Number

- Classification (Prepregs):

- MIL “Part Number” replaced with IPC-4101 version.
- As an example:

- P21E7628RCSCGT

- P21 Prepreg Specification Sheet # 21
- E7628 E Glass Style 7628
- RC Resin Content (nominal, range on PO)
- SC Scaled Flow (nominal, range on PO)
- GT Gel Time (nominal, range on PO)

IPC-4101 Designates a New Part Number

● Classification (Prepregs):

– Resin Content Method

- RC Resin Content %
- TW Treated Weight

– Flow Parameter Method

- MF MIL Flow %
- SC Scaled Flow (ppt)
- NF No Flow
- RE Rheological Flow
- PC % Cure
- DH Delta H

IPC-4101 Designates a New Part Number

- Classification (Prepregs):

- Optional Prepreg Testing Methods

- VC Volatile Content %
- DY Dicy Check
- GT Gel Time (secs.)
- 00 None Specified

Control Plan For Authorized Distributors

● Paragraph 5.2:

- The supplier is responsible for the actions of the distributor.
- Written guidelines must be provided to the distributor addressing such items as:
 - Certificates of Compliance.
 - Storage Conditions of Prepregs.
 - Storage Conditions of Laminates.
 - Lot Control.
 - Inspection, Labeling and Packing Procedures.
 - Internal Audit Procedures.
 - Periodic Audits by the Supplier.