



ASSOCIATION CONNECTING  
ELECTRONICS INDUSTRIES®

IPC-4101B with Amendment 1

# Specification for Base Materials for Rigid and Multilayer Printed Boards

Developed by the Laminate/Prepreg Materials Subcommittee (3-11) of  
the Printed Board Base Materials Committee (3-10) of IPC

***Supersedes:***

IPC-4101B - June 2006  
IPC-4101A with  
Amendment 1 - June 2002  
IPC-4101A - December 2001  
IPC-4101 - December 1997  
IPC-L-108  
IPC-L-109  
IPC-L-112  
IPC-L-115  
IPC-AM-361

Users of this standard are encouraged to participate in the  
development of future revisions.

**Contact:**

IPC  
3000 Lakeside Drive, Suite 309S  
Bannockburn, Illinois  
60015-1249  
Tel 847 615.7100  
Fax 847 615.7105

# Table of Contents

<b>1</b>	<b>SCOPE</b>	1	3.3	Manufacturer Quality Profile	6
1.1	Classification	1	3.4	Qualification Testing	6
1.1.1	Specification Sheet Description	1	3.4.1	Qualification Testing of Laminate	7
1.1.2	Nominal Laminate Thickness	1	3.4.2	Qualification Testing of Prepreg	9
1.1.3	Metal Cladding Type and Nominal Weight/Thickness	1	3.5	Verification of Manufacturer's Quality System	9
1.1.3.1	Metal Cladding Type	1	3.6	Conflict	9
1.1.3.2	Nominal Weight/Thickness	1	3.7	Materials	9
1.1.4	Thickness Tolerance (Laminate)	1	3.7.1	Metal Cladding	9
1.1.5	Surface Quality Class	2	3.7.2	Reinforcement Fabric	9
1.1.6	Reinforcement Style	2	3.7.3	Resin Systems	9
1.1.7	Prepreg Parameters	2	3.8	General Requirements	9
1.1.8	Color	2	3.8.1	Fabricated Sheets and Panels	9
1.1.8.1	Contrast Agents	2	3.8.1.1	Fabricated Laminate Sheet Material	9
1.2	Dimensions and Tolerances	3	3.8.1.2	Fabricated Laminate Panel Material	9
1.2.1	Metric and English Measurements	3	3.8.1.3	Fabricated Prepreg Panels	9
			3.8.1.4	Fabricated Prepreg Rolls	9
<b>2</b>	<b>APPLICABLE DOCUMENTS</b>	3	3.8.2	Inspection Lot	9
2.1	IPC	3	3.8.2.1	Inspection Lot for Laminate	9
2.2	National Conference of Standards Laboratories (NCSL)	4	3.8.2.2	Inspection Lot for Prepreg	9
2.3	International Standards	4	3.8.2.3	Preparation of Samples	10
2.4	Underwriters Laboratories (UL)	4	3.8.2.4	Etching Process and Etchant Removal for Copper Foil Specimens	10
2.5	European Union	4	3.8.2.5	Standard Laboratory Conditions	10
2.6	ASTM International	4	3.8.3	Visual Properties	10
<b>3</b>	<b>REQUIREMENTS</b>	5	3.8.3.1	Laminate Visual Properties	10
3.1	Terms and Definitions	5	3.8.3.1.1	Foil Indentations	10
3.1.1	Qualification Assessment	5	3.8.3.1.2	Wrinkles	10
3.1.2	Quality Conformance Testing	5	3.8.3.1.3	Scratches	10
3.1.3	Manufacturer's Quality System	5	3.8.3.1.4	Plastic Surface Finish of Metal-Clad Single-Sided Base Material	10
3.1.4	Process Control Testing	5	3.8.3.1.5	Surface Finish of Foil after Curing – Except Double Treat	10
3.1.5	Self Declaration	5	3.8.3.1.6	Surface and Subsurface Imperfections	10
3.1.6	Quality Assessment Data	5	3.8.3.2	Prepreg Visual Properties	11
3.1.7	Sample Qualification	5	3.8.3.2.1	Inclusions	11
3.1.8	Production Data	5	3.8.3.2.2	Impregnation Imperfections	11
3.1.9	Customer Test Data	5	3.8.4	Dimensional	11
3.1.10	Internal Assessment	5	3.8.4.1	Length and Width	11
3.1.11	Individual Customer Audit	5	3.8.4.1.1	Length and Width of Laminate	11
3.1.12	Independent Third Party Assessment	5	3.8.4.1.2	Length and Width of Prepreg	11
3.1.13	Epoxy, Multifunctional	5	3.8.4.1.3	Prepreg Roll Width	11
3.1.14	Epoxy, Difunctional	5	3.8.4.1.4	Prepreg Roll Length	12
3.1.15	AABUS	5	3.8.4.2	Thickness	12
3.2	Specification Sheets	6			

3.8.4.2.1	Class A, B, and C Laminate Materials .....	12	3.10.1.6	Glass Transition Temperature ( $T_g$ ) (Optional) .....	15
3.8.4.2.2	Class D Laminate Materials .....	12	3.10.1.7	Delta $T_g$ (Optional) .....	16
3.8.4.2.3	Class K, L, M Laminate Materials .....	12	3.10.1.8	Coefficient of Thermal Expansion (CTE) (Optional) .....	16
3.8.4.2.4	Thickness Tolerance of Laminate Materials .....	12	3.10.1.9	Halogen Content (Optional) .....	16
3.8.4.3	Bow and Twist of Laminate Materials .....	13	3.10.1.10	Decomposition Temperature (Optional Test) .....	16
3.8.4.3.1	Sheets and Panels with Both Dimensions $\geq 300$ mm [11.81 in] .....	13	3.10.1.11	Z-Axis CTE .....	16
3.8.4.3.2	Panels with One or Both Dimensions <300 mm [11.81 in] .....	13	3.10.1.12	Time to Delaminate (TMA) (Optional Test) .....	16
3.9	Physical Requirements .....	13	3.10.2	Chemical Requirements of Prepreg Materials .....	16
3.9.1	Physical Requirements of Laminate Materials .....	13	3.10.2.1	Flammability .....	16
3.9.1.1	Peel Strength .....	13	3.10.2.2	Chemical Resistance (Optional) .....	16
3.9.1.1.1	Peel Strength after Thermal Stress .....	14	3.10.2.3	Presence of Dicyandiamide (Dicy) (Optional) .....	16
3.9.1.1.2	Peel Strength at Elevated Temperature .....	14	3.11	Electrical Requirements .....	16
3.9.1.1.3	Peel Strength after Process Chemicals (Optional) .....	14	3.11.1	Electrical Requirements of Laminate Materials .....	16
3.9.1.2	Dimensional Stability .....	14	3.11.1.1	Permittivity .....	16
3.9.1.3	Flexural Strength .....	14	3.11.1.2	Loss Tangent .....	16
3.9.1.4	Flexural Strength at Elevated Temperature ...	14	3.11.1.3	Volume Resistivity .....	16
3.9.1.5	Thermal Conductivity .....	14	3.11.1.4	Surface Resistivity .....	16
3.9.2	Physical Requirements of Prepreg Materials .....	14	3.11.1.5	Arc Resistance .....	16
3.9.2.1	Resin Content .....	14	3.11.1.6	Dielectric Breakdown .....	16
3.9.2.1.1	Resin Content Percent (RC) (by Treated Weight) .....	14	3.11.1.7	Electric Strength .....	16
3.9.2.1.2	Resin Content Percent (RC) (by Burn-Off) ..	14	3.11.2	Electrical Requirements of Prepreg Materials .....	16
3.9.2.1.3	Treated Weight Total (TW) .....	14	3.11.2.1	Permittivity .....	17
3.9.2.1.4	Variation Within a Panel .....	14	3.11.2.2	Loss Tangent .....	17
3.9.2.2	Flow Parameter .....	14	3.11.2.3	Electric Strength .....	17
3.9.2.2.1	Resin Flow Percent (MF) .....	14	3.12	Environmental Requirements .....	17
3.9.2.2.2	Scaled Flow Thickness (SC) .....	14	3.12.1	Environmental Requirements of Laminate Materials .....	17
3.9.2.2.3	No Flow (NF) .....	14	3.12.1.1	Moisture Absorption .....	17
3.9.2.2.4	Rheological Flow (RE) .....	15	3.12.1.2	Fungus Resistance .....	17
3.9.2.2.5	Delta H (DH) .....	15	3.12.1.3	Pressure Vessel (Optional) .....	17
3.9.2.2.6	Percent Cure (PC) .....	15	3.12.1.4	Conductive Anodic Filament (CAF) Growth (Optional) .....	17
3.9.2.2.7	Gel Time (GT) (Optional Test) .....	15	3.12.2	Environmental Requirements of Prepreg Materials .....	17
3.9.2.2.8	Volatile Content (VC) (Optional Test) .....	15	3.12.2.1	Fungus Resistance .....	17
3.9.2.2.9	Thermal Conductivity (Prepreg Reference) ..	15	3.13	Substitutability .....	17
3.10	Chemical Requirements .....	15	3.13.1	Substitutability of Classes of Pits and Dents .....	17
3.10.1	Chemical Requirements of Laminate Materials .....	15	3.13.2	Substitutability of Classes of Thickness Tolerance .....	17
3.10.1.1	Flammability .....	15	3.13.3	Remarking of Substituted Laminates .....	17
3.10.1.2	Thermal Stress .....	15			
3.10.1.3	Solderability .....	15			
3.10.1.4	Chemical Resistance (Optional) .....	15			
3.10.1.5	Metal Surfaces Cleanability .....	15			



# Specification for Base Materials for Rigid and Multilayer Printed Boards

## 1 SCOPE

This specification covers the requirements for base materials, herein referred to as laminate or prepreg, to be used primarily for rigid or multilayer printed boards for electrical and electronic circuits.

**1.1 Classification** The system shown below identifies clad and unclad laminate or prepreg base materials. The specification sheets serve as a cross-reference connecting the outlined callout system in this document to previously used systems.

Example for laminate base materials where this specification is referenced:

L	Material Designator (see 1.1.1)
25	Specification Sheet Number (see 1.1.1)
1500	Nominal Laminate Thickness (see 1.1.2)
C1/C1	Metal Cladding Type and Nominal Weight/Thickness (see 1.1.3)
A	Thickness Tolerance Class (see 1.1.4)
A	Surface Quality Class (see 1.1.5)

Example for prepreg base materials where this specification is referenced:

P	Material Designator (see 1.1.1)
25	Specification Sheet Number (see 1.1.1)
E7628	Reinforcement Style (see 1.1.6)
TW	Resin Content Method (see 1.1.7)
RE	Flow Parameter Method (see 1.1.7)
VC	Optional Prepreg Method (see 1.1.7)

**1.1.1 Specification Sheet Description** At the end of this document is a series of specification sheets. Each specification sheet outlines requirements for both laminate and prepreg for each product grade. The specification sheets are organized by a specific reinforcement type, resin system, and/or construction and are provided with a specification sheet number for ordering purposes. For convenience, the laminate and prepreg requirements for materials of the like composition are on the same specification sheet. Material Designator “L” indicates laminate material and Material Designator “P” indicates prepreg material as shown in designation examples in 1.1. When certifying to multiple specification sheets, the strongest performance requirements **shall** apply.

The headings for each specification sheet include reference definitions for the material, which cover the reinforcements, resin systems, flame retardants, and fillers used, as well as its other known identifications and glass transition temperature,  $T_g$ . The specific line items within the specification sheets are the requirements that material **shall** meet in order to be certified to this specification.

**1.1.2 Nominal Laminate Thickness** The nominal thickness is identified by four digits. For all substrates covered by this document, thicknesses may be specified or measured either over the cladding or over the dielectric (see 1.1.4 and 3.8.4.2). For metric specification, the first digit represents whole millimeters, the second represents tenths of millimeters, etc. For orders requiring English units, the four digits indicate the thickness in ten-thousandths of an inch (tenths of mils). In the example shown in 1.1, 1500 is designated for the English unit usage of 0600 for a laminate with thickness of 1.5 mm [59.1 mil].

**1.1.3 Metal Cladding Type and Nominal Weight/Thickness** The type and nominal weight or thickness of the metallic cladding for laminate base material is identified by five designators. The first and fourth designators indicate the type of cladding; the third designator is a slash mark that differentiates sides of the base material; the second and fifth designators indicate the nominal weight or thickness of the metallic cladding.

**1.1.3.1 Metal Cladding Type** The types of metallic cladding and the designators representing them are shown in Table 1-1. Table 1-1 is provided as a reference only. The referee document is the latest version of IPC-CF-148, IPC-4562, or IPC-CF-152 as appropriate. Cladding types C and R, and cladding types H and S, may be used interchangeably as agreed upon between user and supplier. Cladding type H can be used for type C and type S can be used for type R. Cladding type R may be substituted for type C, and cladding type S may be substituted for type H.

**1.1.3.2 Nominal Weight/Thickness** The weight or thickness of metallic cladding and the designators representing them are listed in Table 1-2. Table 1-2 is provided as a reference only. The referee document is the latest version of IPC-CF-148, IPC-4562, or IPC-CF-152 as appropriate.

**1.1.4 Thickness Tolerance (Laminate)** The class of thickness tolerance for laminate base material is identified by either A, B, C, D, K, L, M, or X (as agreed upon