Sectional Design Standard for Rigid Organic Printed Boards

Developed by the IPC-2221/2222 Task Group (D-31B) of the Rigid Printed Board Committee (D-30) of IPC

Users of this publication 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

Supersedes:
IPC-2222 - February 1998
IPC-D-275 - September 1991
Table of Contents

1 SCOPE .........................................................1
  1.1 Purpose ......................................................1
  1.2 Document Hierarchy ........................................1
  1.3 Presentation ................................................1
  1.4 Interpretation ...............................................1
  1.5 Definition of Terms ........................................1
  1.5.1 As Agreed Between User and Supplier (AABUS) ..........1
  1.6 Classification of Products ..................................1
  1.6.1 Printed Board Type ........................................1
  1.7 Applicability ................................................1
  1.8 Revision Level Changes ....................................1

2 APPLICABLE DOCUMENTS .................................2
  2.1 IPC .........................................................2
  2.2 Underwriters Laboratories ................................2

3 GENERAL REQUIREMENTS .................................2
  3.1 Performance Requirements .................................2

4 MATERIALS ..................................................2
  4.1 Material Selection .........................................2
  4.2 Dielectric Base Materials (Including Prepregs and Adhesives) ........................................2
  4.2.1 Epoxy Laminates ........................................2
  4.2.2 High Temperature Laminates ................................3
  4.2.3 Special Clad Materials ..................................3
  4.2.4 Other Laminates ..........................................3
  4.3 Laminate Materials .........................................3
  4.3.1 Measurement of Dielectric Thickness .................5
  4.3.2 Dielectric Thickness/Spacing ............................6
  4.3.3 Laminate Properties ....................................6
  4.3.4 Prepreg ..................................................6
  4.3.5 Single-Clad Laminates ..................................7
  4.3.6 Double-Clad Laminates ................................7
  4.3.7 Laminate Material Code Designation ...................7
  4.4 Conductive Materials .....................................7
  4.5 Organic Protective Coatings ................................7
  4.6 Markings and Legends ......................................7

5 MECHANICAL/PHYSICAL PROPERTIES .....................14
  5.1 Fabrication Requirements ...............................14
  5.2 Product/Printed Board Configuration ..................14
  5.2.1 Printed Board Geometries ..............................14

6 ELECTRICAL PROPERTIES ...............................19

7 THERMAL MANAGEMENT ..................................19

8 COMPONENT AND ASSEMBLY ISSUES ......................19
  8.1 General Attachment Requirements ......................19
  8.1.1 Attachment of Wires/Leads to Terminals .............19
  8.1.2 Printed Board Extractors ...............................19

9 HOLE/INTERCONNECTIONS ...............................21
  9.1 General Requirements for Lands with Holes ............21
  9.1.1 Land Requirements .....................................21
  9.1.2 Thermal Relief in Conductor Planes ..................21
  9.1.3 Clearance Area in Planes ..............................22
  9.1.4 Nonfunctional Lands ...................................23
  9.1.5 Conductive Pattern Feature Location Tolerance ......24
  9.2 Holes ......................................................25
  9.2.1 Unsupported Holes .....................................25
  9.2.2 Plated-Through Holes (PTHs) .........................25
  9.2.3 Etchback ................................................26

10 GENERAL CIRCUIT FEATURE REQUIREMENTS .............26
  10.1 Conductor Characteristics .............................26
  10.1.1 Edge Spacing .........................................26
  10.1.2 Balanced Conductors ................................26
  10.1.3 Flush Conductors for Rotating or Sliding Contacts ........................................27
  10.2 Land Characteristics ....................................28
  10.2.1 Offset Lands .........................................28
  10.3 Large Conductive Areas ................................28

11 DOCUMENTATION ..........................................28
  11.1 Filled Holes ..............................................28
  11.2 Nonfunctional Holes ......................................28

12 QUALITY ASSURANCE .....................................28
Figures

Figure 4–1 Dielectric Layer Thickness Measurement .............5
Figure 4–2 Designer/End User Materials Selection Map .........13
Figure 5–1 Borders and Margins in Printed Board Panels, mm [in] .............................................14
Figure 5–2 Scoring Parameters ..................................................16
Figure 5–3 Conductor Clearance for V-Groove Scoring .....17
Figure 5–4 Breakaway Tabs .....................................................17
Figure 5–5 Breakaway (Routed Pattern) with Routed Slots ...18
Figure 5–6 Routed Slots ..........................................................18
Figure 8–1 Permanent Printed Board Extractor ....................20
Figure 8–2 External Printed Board Extractor .......................20
Figure 9–1 Clearance Area in Planes ....................................22
Figure 9–2 Foil Web Size .....................................................23
Figure 9–3 Lead-to-hole Clearance ......................................25
Figure 10–1 Typical Flush Circuit ........................................27
Figure 10–2 Surface Flushness Conditions .........................27
Figure 10–3 Cross-hatched Large Conductive Layers with Isothermal Conductors ..................28

Tables

Table 4–1 Clad Laminate UL Maximum Operating Temperatures .........................................................3
Table 4–2 Advantages and Disadvantages of some Common Laminate Materials .................................4
Table 4–3 Common Base Material Thicknesses for Single & Double-Sided Printed Boards, mm [in] ..........6
Table 4–4 FR-4 Copper Clad Laminate Construction Selection Guide .................................................8
Table 4–5 High Tc FR-4 Copper Clad Laminate Construction Selection Guide ................................9
Table 4–6 Cyanate Ester (170 to 250° Tc) Copper Clad Laminate Construction Selection Guide ........10
Table 4–7 BT Copper Clad Laminate Construction Selection Guide .............................................11
Table 4–8 Polyimide Copper Clad Laminate Construction Selection Guide ....................................12
Table 5–1 Standard Scoring Parameters, µm [in] ..........16
Table 5–2 Tolerance of Profiles, Cutouts, Notches, and Keying Slots, as Machined, mm [in] .............18
Table 5–3 Printed Board Thickness Tolerance Levels ........19
Table 9–1 Pad to Plane Clearance, mm [in] .................22
Table 9–2 Nonfunctional Land Considerations .................24
Table 9–3 Feature Location Tolerances (Lands, Conductor Pattern, etc.) (Diameter True Position), mm [in] .............24
Table 9–4 Diameter Tolerance Range for Unsupported Holes, mm [in] ............................................25
Table 9–5 PTH Diameter to Lead Diameter Relationships, mm [in] ..............................................25
Table 9–6 PTH Aspect Ratio ....................................................26
Table 9–7 Minimum PTH Diameter Tolerance Range, (Difference Between High and Low Hole Size Limits), mm [in] .............26
Table 10–1 Surface Flushness Requirements, mm [in] ..........27
Sectional Design Standard for Rigid Organic Printed Boards

1 SCOPE
This standard establishes the specific requirements for the design of rigid organic printed boards:

1.1 Purpose  The requirements contained herein are intended to establish specific design details that **shall** be used in conjunction with IPC-2221 to produce designs intended to mount and attach components. The components may be through-hole, surface mount, fine pitch, ultra-fine pitch, array mounting or un-packaged bare die.

The organic materials may be homogeneous, reinforced, or used in combination with inorganic materials; the interconnections may be single, double, or multilayered. They may be any combination able to perform the physical, thermal, environmental, and electronic function.

1.2 Document Hierarchy  Document hierarchy **shall** be in accordance with the generic standard IPC-2221.

1.3 Presentation  Presentation **shall** be in accordance with the generic standard IPC-2221.

1.4 Interpretation  Interpretation **shall** be in accordance with the generic standard IPC-2221.

1.5 Definition of Terms  The definition of all terms used herein **shall** be in accordance with IPC-T-50 and as defined in 1.5.1.

1.5.1 As Agreed Between User and Supplier (AABUS)  Indicates additional or alternate requirements to be decided between the user and the supplier in the procurement documentation. Examples include contractual requirements, modifications to purchase documentation and information on the drawing. Agreements can be used to define test methods, conditions, frequencies, categories or acceptance criteria within a test, if not already established.

1.6 Classification of Products  Classification of products **shall** be in accordance with the generic standard IPC-2221 and as defined in 1.6.1.

1.6.1 Printed Board Type  This standard provides design information for different printed board types. Printed board types are classified as:

Type 1 – Single-Sided Printed Board

Type 2 – Double-Sided Printed Board

Type 3 – Multilayer Printed Board without blind or buried vias

Type 4 – Multilayer Printed Board with blind and/or buried vias

Type 5 – Multilayer Metal Core Printed Board without blind or buried vias

Type 6 – Multilayer Metal Core Printed Board with blind and/or buried vias

1.7 Applicability  The contents of this standard may not apply to certain leading edge technologies. Refer to IPC-2221 for additional information.

1.8 Revision Level Changes  Changes that were incorporated in the current revision of this specification are indicated throughout by gray shading of the relevant subsection(s). Changes to a figure or table are indicated by gray shading of the Figure or Table header.