



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-2222

Sectional Design Standard for Rigid Organic Printed Boards

ANSI/IPC-2222

February 1998

A standard developed by IPC

Supersedes IPC-D-275
September 1991

2215 Sanders Road, Northbrook, IL 60062-6135
Tel. 847.509.9700 Fax 847.509.9798
www.ipc.org

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for Engineering (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

Notice

IPC Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of IPC from manufacturing or selling products not conforming to such Standards and Publication, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than IPC members, whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by IPC without regard to whether their adoption may involve patents on articles, materials, or processes. By such action, IPC does not assume any liability to any patent owner, nor do they assume any obligation whatever to parties adopting the Recommended Standard or Publication. Users are also wholly responsible for protecting themselves against all claims of liabilities for patent infringement.

IPC Position Statement on Specification Revision Change

It is the position of IPC's Technical Activities Executive Committee (TAEC) that the use and implementation of IPC publications is voluntary and is part of a relationship entered into by customer and supplier. When an IPC standard/guideline is updated and a new revision is published, it is the opinion of the TAEC that the use of the new revision as part of an existing relationship is not automatically required by the contract. The TAEC recommends the use of the latest revision.

Adopted October 6, 1998

Why is there a charge for this standard?

Your purchase of this document contributes to the ongoing development of new and updated industry standards. Standards allow manufacturers, customers, and suppliers to understand one another better. Standards allow manufacturers greater efficiencies when they can set up their processes to meet industry standards, allowing them to offer their customers lower costs.

IPC spends hundreds of thousands of dollars annually to support IPC's volunteers in the standards development process. There are many rounds of drafts sent out for review and the committees spend hundreds of hours in review and development. IPC's staff attends and participates in committee activities, typesets and circulates document drafts, and follows all necessary procedures to qualify for ANSI approval.

IPC's membership dues have been kept low in order to allow as many companies as possible to participate. Therefore, the standards revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards, why not take advantage of this and the many other benefits of IPC membership as well? For more information on membership in IPC, please visit www.ipc.org or call 847/790-5372.

Thank you for your continued support.



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

ANSI/IPC-2222

Sectional Design Standard for Rigid Organic Printed Boards

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

APPROVED JANUARY 7, 1999 BY



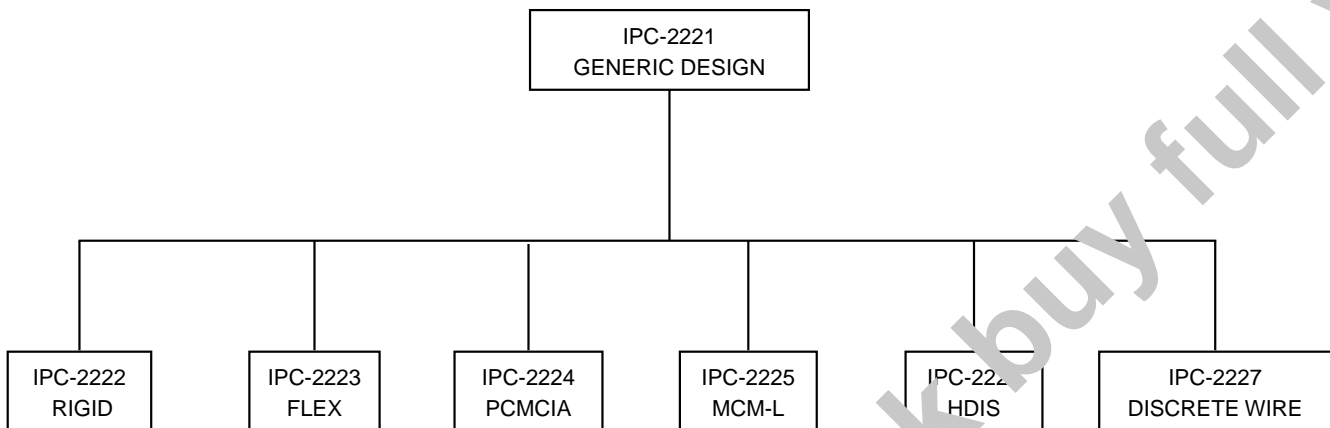
AMERICAN NATIONAL STANDARDS INSTITUTE

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

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798

HIERARCHY OF IPC DESIGN SPECIFICATIONS
(2220 SERIES)



FOREWORD

This standard is intended to provide information on the detailed requirements for organic rigid printed board design. All aspects and details of the design requirements are addressed to the extent that they can be applied to the unique requirements of those designs that use organic rigid (reinforced) materials or organic materials in combination with inorganic materials (metal, glass, ceramic, etc.) to provide the structure for mounting and interconnecting electronic, electromechanical, and mechanical components.

The information contained herein is intended to supplement generic engineering considerations and design requirements identified in IPC-2221. When coupled with the engineering design input, the complete disclosure should facilitate the appropriate selection process of the materials and the detailed organic rigid structure fabrication technology necessary to meet the engineering design objectives.

The selected component mounting and interconnecting technology for the printed board should be commensurate with the requirements provided and the specific focus of this sectional document.

IPC's documentation strategy is to provide distinct documents that focus on specific aspect of electronic packaging issues. In this regard document sets are used to provide the total information related to a particular electronic packaging topic. A document set is identified by a four digit number that ends in zero (0).

Included in this set is the generic information which is contained in the first document of the set and identified by the four digit set number. The generic standard is supplemented by one or many sectional documents each of which provide specific focus on one aspect of the topic or the technology selected. The designer of the printed board, needs as a minimum, the generic, the sectional of the chosen technology, the generic engineering considerations, and the engineering description of the final product.

Failure to have all information available prior to starting a design may result in a product that is difficult to manufacture or exceeds the cost predictions or expectations of the printed board.

As technology changes, specific focus standards will be updated, or new focus standards added to the document set. The IPC invites input on the effectiveness of the documentation and encourages user response through completion of "Suggestions for Improvement" forms located at the end of each document

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the IPC-D-275 Task Group (D-31b) of the Rigid Printed Board Committee (D-30) are shown below, it is not possible to include all of those who assisted in the evolution of this Standard. To each of them, the members of the IPC extend their gratitude.

Rigid Printed Board Committee	IPC-D-275 Task Group (D-31b)	Technical Liaison of the IPC Board of Directors
Chairman Bob Neves Microtek Lab	Chairman Lionel Fullwood Wong's Kong King Int'l	Ronald Underwood Circuit Center
IPC-D-275 Task Group		
Richard Altenhofen, Motorola GSTG	Joe Fjelstad, Tessera Inc.	Susan Mansilla, Robisan Laboratory Inc.
Daniel Arnold, EMD Associates Inc.	Martin G. Freedman, Amp Inc.	Lester M. Mazarek, CAE Electronics Ltd.
Lance A. Auer, Hughes Missile Systems Company	Lionel Fullwood, Wong's Kong King Int'l	Kevin J. Miller, CAE Electronics Ltd.
Nanci J. Baggett, Printed Circuit Resources	Mahendra S. Gandhi, Hughes Aircraft Co.	John H. Morton, Lockheed Martin Federal Systems
Steve Bakke, Alliant Techsystems Inc.	Paul Grande, Jr., U.S. Navy	Karl B. Mueller, Hughes Aircraft Co.
Karl J. Bates, Lucent Technologies	Michael R. Green, Lockheed Martin Missiles & Space	Joseph L. Mulcahy, Methode Electronics Inc. East
Robert E. Beauchamp, Lockheed Martin Missiles & Space	Lyle F. Harford, Texas Instruments Inc.	Benny Nilsson, Ericsson Telecom AB
Frank Belisle, Sundstrand Aerospace	Andrew J. Heidelberg, Maroon Custom Mfg. Services Inc.	R. Bruce. Officer, Sanders, A Lockheed Martin Co.
David W. Bittle, Raytheon Aircraft Company	Ralph J. Hersey, Ralph Hersey & Associates	Scott S. Opperhauser, Trace Laboratories - East
Daniel L. Botts, Hughes Training, Inc.	Phillip E. Hinton, Hinton -PWB- Engineering	John Papinko, Gulston Data Systems
John Bourque, Shure Brothers Inc.	Octavian Iordache, Circo Craft Co. Inc.	Ron Payne, Primex Aerospace
Scott A. Bowles, Sovereign Circuits Inc.	Doc. Jensen, Endicott Research Group	Richard Peyton, Lockheed Martin Astronautics
Stephen G. Bradley, CAL Corporation	Arturo J. Jordan, Pollak Transprtn Electrnics Div	Larry L. Puckett, Sandia National Labs Albuquerque
Jim Brock, SCI Systems Inc.	John A. Kelly, Motorola GSTG	Paul J. Quinn, Lockheed Martin Missiles & Space
Ignatius Chong, Celestica	Therese Kokocinski, Northrop Grumman Corporation	Kurt Ravenfeld, Lockheed Martin Corporation
David J. Corbett, DSCC	Stephen Korchynsky, Lockheed Martin Federal Systems	Randy R. Reed, Merix Corporation
Brian Crowley, Hewlett Packard Laboratories	George T. Kotecki, Northrop Grumman Corporation	Bruce C. Rietdorf, Hughes Defense Communications
Georgia DeGrandis, Abco Ceag Power Supplies, Inc.	Thomas E. Kurtz, Hughes Defense Communications	Jerald G. Rosser, Hughes Missile Systems Company
Yong Deng, Owens Corning Fiberglass Corp.	Clifford H. Lamson, Harris Corp.	Vincent J. Ruggeri, Raytheon Company
Michael J. DiFranza, The Mitre Corp.	Bonnie Lauch, Honeywell Inc.	Don W. Rumps, Lucent Technologies Inc.
C. Lynn D. Priest, Lockheed Martin Flight Systems	Stan C. Mackzum, Ericsson Inc.	Robert Russell, Texas Instruments Inc.
Theodore Edwards, Honeywell Inc.	James F. Maguire, Boeing Defense & Space Group	Merlyn L. Seltzer, Hughes Delco Systems Operations
Will J. Edwards, Lucent Technologies Inc.	David J. Malanchuk, Eastman Kodak Co. KAD	Nusrat Sherali, IBM Corp.
Werner Engelmaier, Engelmaier Associates, Inc.	Wesley R. Malewicz, Siemens Medical Systems Inc.	Lowell Sherman, DSCC
Thomas R. Etheridge, McDonnell Douglas Aerospace		

Rae Shyne, Prototron Circuits Inc.
Grant (Rick) W. Smedley, III, Printed
Circuit Resources
E. Lon. Smith, Lucent Technologies
Inc.
Joseph J. Sniezek, IBM Corp./
Endicott Electronic Pa
William F. Spurny, AlliedSignal
Aerospace
Robert J. St. Pierre, New England
Laminates

Thomas K. Stewart, Speedy Circuits
Gil Theroux, Honeywell Inc.
Ronald E. Thompson, U.S. Navy
Max E. Thorson, Compaq Computer
Corporation
Lutz E. Treutler, Fachverband
Elektronik Design
Robert Vanech, Northrop Grumman
Norden Systems

Eric L. Vollmar, Methode Electronics
Inc.
Forrest L. Voss, Rockwell
International
Rich Warzecha, Advanced Flex Inc.
Clark F. Webster, Computing Devices
International
David A. White, Input/Output Inc.

Currently in preview, click buy full version

Table of Contents

1.0 SCOPE	1	7.0 THERMAL MANAGEMENT	16
1.1 Purpose	1	8.0 COMPONENT AND ASSEMBLY ISSUES	16
1.2 Document Hierarchy	1	8.1 General Attachment Requirements	16
1.3 Presentation	1	8.1.1 Attachment of Wires/Leads to Terminals	16
1.4 Interpretation	1	8.1.2 Board Extractors	16
1.5 Classification of Products	1	9.0 HOLE/INTERCONNECTIONS	16
1.5.1 Board Type	1	9.1 General Requirements for Lands with Holes	16
1.6 Assembly Types	1	9.1.1 Land Requirements	16
2.0 APPLICABLE DOCUMENTS	1	9.1.2 Thermal Relief in Conductor Pads	16
2.1 Institute for Interconnecting and Packaging Electronic Circuits (IPC)	1	9.1.3 Clearance Area in Plated Through Holes	17
2.2 Underwriters Laboratories	3	9.1.4 Nonfunctional Lands	18
3.0 GENERAL REQUIREMENTS	3	9.1.5 Conductive Pattern Feature Location Tolerance	18
3.1 Performance Requirements	3	9.2 Holes	18
4.0 MATERIALS	3	9.2.1 Unsupported Holes	18
4.1 Material Selection	3	9.2.2 Plated-Through Holes	19
4.2 Dielectric Base Materials (Including Prepregs and Adhesives)	3	9.2.3 Etchback	19
4.2.1 Epoxy Laminates	3	9.3 Drill Size Recommendations for Printed Boards	20
4.2.2 High-Temperature Laminates	3	10.0 GENERAL CIRCUIT FEATURE REQUIREMENTS	20
4.2.3 Special Clad Materials	3	INDEX	23
4.2.4 Other Laminates	3	10.1 Conductor Characteristics	20
4.3 Laminate Materials	3	10.1.1 Edge Spacing	20
4.3.1 Measurement of Dielectric Thickness	3	10.1.2 Balanced Conductors	21
4.3.2 Dielectric Thickness/Spacing	4	10.1.3 Flush Conductors for Rotating or Sliding Contacts	21
4.3.3 Laminate Properties	5	10.1.4 Metallic Finishes for Flush Conductors	21
4.3.4 Prepreg	5	10.2 Land Characteristics	21
4.3.5 Single-Clad Laminates	5	10.2.1 Lands for Interfacial Connection Vias	21
4.3.6 Double-Clad Laminates	5	10.2.2 Offset Lands	21
4.3.7 Laminate Material	5	10.2.3 Conductive Pattern Feature Location Tolerance	21
4.4 Conductive Materials	13	10.2.4 Nonfunctional Lands	21
4.5 Organic Protective Coatings	13	10.3 Large Conductive Areas	21
4.6 Markings and Legends	13	11.0 DOCUMENTATION	22
5.0 MECHANICAL/PHYSICAL PROPERTIES	13	11.1 Filled Holes	22
5.1 Fabrication Requirements	13	11.2 Nonfunctional Holes	22
5.2 Product/Board Configuration	13	12.0 QUALITY ASSURANCE	22
5.2.1 Board Geometries	13		
5.2.2 Support	13		
5.3 Assembly Requirements	13		
5.3.1 Assembly and Test	14		
5.4 Dimensioning Systems	15		
5.4.1 Grid Systems	15		
5.4.2 Profiles, Cutouts and Notches	15		
6.0 ELECTRICAL PROPERTIES	16		
		Figures	
		Figure 1-1 Electrical assembly types	2
		Figure 4-1 Dielectric layer thickness measurement	4

Figure 4-2	Designer / end user materials selection map	11	Table 4-5	BT Copper Clad Laminate Construction Selection Guide	9
Figure 5-1	Panel borders	14	Table 4-6	Polyimide Copper Clad Laminate Construction Selection Guide.....	10
Figure 5-2	Scoring parameters	14	Table 5-1	Panel Size to Manufacturing Operation Relationships	14
Figure 5-3	Breakaway tabs	15	Table 5-2	Standard Scoring Parameters.....	14
Figure 8-1	Permanent board extractor.....	16	Table 5-3	Tolerance of Profiles, Cutouts, Notches, and Keying Slots, as Machined, mm	15
Figure 8-2	External board extractor	16	Table 9-1	Feature Location Tolerances (Lands, Conductor Pattern, etc.) (Diameter True Position).....	16
Figure 9-1	Clearance area in planes, mm	17	Table 9-2	Minimum Unsupported Holes Tolerance Range (Difference between high and low hole size limits).....	18
Figure 9-2	Foil web size.....	18	Table 9-3	Plated-Through Hole Diameter to Lead Diameter Relationships	20
Figure 9-3	Lead-to-hole clearance.....	19	Table 9-4	Plated-Through Hole Aspect Ratio.....	20
Figure 10-1A	Typical flush circuit	21	Table 9-5	Minimum Plated-Through Hole Diameter Tolerance Range, mm (Difference between high and low hole size limits).....	20
Figure 10-1B	Surface flushness conditions.....	22	Table 9-6	Minimum Drilled Hole Size for Plated-Through Hole Vias	20
Figure 10-2	Cross-hatched large conductive layers with isothermal conductors.....	22	Table 9-7	Drill Size Recommendations Related to Maximum Board Thickness	20
			Table 10-1	Surface Flushness Requirements	21
Tables					
Table 4-1	Clad Laminate Maximum Operating Temperatures.....	4			
Table 4-2	FR-4 Copper Clad Laminate Construction Selection Guide	6			
Table 4-3	High T _G FR-4 Copper Clad Laminate Construction Selection Guide.....	7			
Table 4-4	Cyanate Ester (170 to 250° T _G) Copper Clad Laminate Construction Selection Guide	8			

Sectional Design Standard for Rigid Organic Printed Boards

1.0 SCOPE

This standard establishes the specific requirements for the design of rigid organic printed boards and other forms of component mounting and interconnecting structures. The organic materials may be homogeneous, reinforced, or used in combination with inorganic materials; the interconnections may be single, double, or multilayered.

1.1 Purpose The requirements contained herein are intended to establish specific design details that **shall** be used in conjunction with IPC-2221 (see 2.0) to produce detailed designs intended to mount and attach passive and active components.

The components may be through-hole, surface mount, fine pitch, ultra-fine pitch, array mounting or unpackaged bare die. The materials 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 Classification of Products Classification of Products **shall** be in accordance with the generic standard IPC-2221 and as follows:

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

- Type 1 — Single-Sided Printed Board
- Type 2 — Double-Sided Printed Board
- Type 3 — Multilayer Board without Blind or Buried Vias
- Type 4 — Multilayer Board with Blind and/or Buried Vias
- Type 5 — Multilayer Metal-Core Board without Blind or Buried Vias
- Type 6 — Multilayer Metal-Core Board with Blind and/or Buried Vias

1.6 Assembly Types A type designation signifies further sophistication describing whether components are mounted on one or both sides of the packaging and interconnecting

structure. Type 1 defines an assembly that has components mounted on only one side; Type 2 is an assembly with components on both sides. Type 2, Class A is not recommended.

Figure 1-1 shows the relationship of two types of assemblies.

The need to apply certain design concepts should depend on the complexity and precision required to produce a particular land pattern or P&I structure. Any design class may be applied to any of the end-product equipment categories; therefore, a moderate complexity (Type 1B) would define components mounted on one side (all surface mounted) and when used in a Class 2 product (dedicated service electronics) is referred to as a Type 1B, Class 2. The product described as a Type 1B, Class 2 might be used in any of the end-use applications; the selection of class being dependent on the requirements of the customers using the application.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. If a conflict of requirements exist between IPC-2222 and those listed below, IPC-2222 takes precedence.

The revision of the document in effect at the time of solicitation **shall** take precedence.

2.1 Institute for Interconnecting and Packaging Electronic Circuits (IPC)¹

IPC-EG-140 Specification For Finished Fabric Woven From "E" Glass for Printed Board

IPC-MF-150 Metal Foil for Printed Wiring Applications

IPC-CF-152 Composite Metallic Materials Specification for Printed Wiring Boards

IPC-D-279 Design Guidelines for Reliable Surface Mount Technology Printed Board Assemblies

IPC-TM-650 Test Methods Manual

Method 2.1.1 Microsectioning

Method 2.1.6 Thickness of Glass Fabric

IPC-SM-782 Surface Mount Design and Land Pattern Standard

1. IPC, 2215 Sanders Road, Northbrook, IL 60062