

IPC-6017A

2021 - August

Qualification and Performance Specification for Printed Boards Containing Embedded Active and Passive Circuitry

*Supersedes IPC-6017
March 2009*

An international standard developed by IPC



BUILD ELECTRONICS BETTER

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee (TAEC) 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 the Environment (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 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 publication 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 automatic unless required by the contract. The TAEC recommends the use of the latest revision. Adopted October 6, 1998

Why is there a charge for this document?

Your purchase of this document contributes to the ongoing development of new and updated industry standards and publications. 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 and publications 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 to allow as many companies as possible to participate. Therefore, the standards and publications revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards and publications, 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 847/597-2872.

Thank you for your continued support.



IPC-6017A

Qualification and Performance Specification for Printed Boards Containing Embedded Active and Passive Circuitry

Developed by the Embedded Devices Process Implementation
Subcommittee (D-55) of the Embedded Components Committee
(D-50) of IPC

Supersedes:

IPC-6017 – March 2009

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

Contact:

IPC
3000 Lakeside Drive, Suite 105N
Bannockburn, Illinois
60015-1249
Tel 847 615.7100
Fax 847 615.7105

Acknowledgment

Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the Embedded Devices Process Implementation Subcommittee (D-55) of the Embedded Components Committee (D-50) 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.

Embedded Components Committee	Embedded Devices Process Implementation Subcommittee	Technical Liaison of the IPC Board of Directors
Chair Steve Vetter Naval Surface Warfare Ctr	Chair Rajesh Kumar TTM Technologies	Bob Neves Microtek (Changzhou) Laboratories
	Vice Chair Bruce Hughes Nvidia Corporation	
Embedded Devices Process Implementation Subcommittee		
Neil Bolding MacDermid Alpha Automotive	Mahendra Gandhi Northrop Grumman Space Systems	Robert Neves Microtek Laboratories China
Marc Carter Aeromarc, LLC	Arnaud Grivon Thales Global Services	William Newhard DownStream Technologies, LLC
Zhiman Chen Zhuzhou CRRC Times Electric Co., Ltd.	Hardeep Heer FTG Circuits	Jan Obrzut NIST
Robert Cooke NASA Johnson Space Center	Leo Huang APCB Electronics (Thailand) Co., Ltd	Jan Pedersen Elmatica AS
Nathaniel Dobrzynski MacDermid Alpha Automotive	Bruce Hughes Nvidia Corporation	Michael Schleicher Semikron Elektronik GmbH Co. KG
Don Dupriest Lockheed Martin Missiles & Fire Control	Jennie Hwang H-Technologies Group	Bhanu Sood NASA Goddard Space Flight Center
Ernst Eggelaar Microtronic	Suriyakan Kleitz Schlumberger Well Services	Crystal Vanderpan UL LLC
Gary Erickson Sanmina Corporation	Rajesh Kumar TTM Technologies	Udo Welzel Robert Bosch GmbH
Dennis Fritz MacDermid Enthone Electronics Solutions	John Lauffer TTM Technologies	Martin Wickham National Physical Laboratory
	James Monarchio TTM Technologies	

Special Recognition

IPC recognizes the following group of people who showed exceptional leadership and effort in the development of IPC-6017A. Their efforts accelerated the process of publishing this much needed revision.

Gary Erickson Sanmina Corporation	Rajesh Kumar TTM Technologies	Bhanu Sood NASA Goddard Space Flight Center
Bruce Hughes Nvidia Corporation	Benjamin Piepgrass Southwest Research Institute	

Table of Contents

1 SCOPE	1	3.2.6 Polymer Coating (Solder Mask)	7
1.1 Purpose	1	3.2.7 Resistor Materials	7
1.2 Classification	1	3.2.8 Capacitor Materials	7
1.3 Measurement Units	1	3.2.9 Coatings for Embedded Devices	7
1.4 Definition of Requirements	1	3.2.10 Underfill Materials	7
1.5 Process Control Requirements	2	3.2.11 Backfill Materials	7
1.6 Order of Precedence	2	3.2.12 Discrete Active Materials	7
1.6.1 Conflict	2	3.2.13 Discrete Passive Materials	7
1.6.2 Clause References	2	3.2.14 Attach Materials	8
1.6.3 Procurement Documentation	2	3.2.15 Printed Materials	8
1.7 Quality Conformance	2	3.2.16 Other Materials for Embedded Devices	8
1.8 Abbreviations and Acronyms	2	3.3 Visual Examination	8
1.9 Terms and Definitions	3	3.3.1 Edges	8
1.9.1 Embedded Passive Materials	3	3.3.2 Laminate Imperfections	9
1.9.2 Embedded Circuitry	3	3.3.3 Lifted Lands	9
1.9.3 Embedded Active Devices	3	3.3.4 Solderability	10
1.10 Embedded Circuitry Device Categories	3	3.3.5 Plating Adhesion	10
1.10.1 Embedded Passive Device Categories	3	3.3.6 Printed Board Contact, Junction of Au Plate to Solder Finish	10
1.10.2 Placed Embedded Active Devices	3	3.3.7 Separation Between Printed Materials and Printed Materials and Substrate	10
1.11 Documentation Hierarchy	3	3.3.8 Surface Cracks on Printed Materials	10
1.12 Selection for Procurement	3	3.3.9 Foreign Object Debris (FOD)	10
1.12.1 Production Master and Database	4	3.3.10 Registration	10
1.12.2 Deviations and Waivers	4	3.3.11 Dielectric Wetting	11
2 APPLICABLE DOCUMENTS	4	3.3.12 Printed and Formed Materials Adhesion	11
2.1 IPC	4	3.3.13 Marking	11
2.2 Joint Industry Standards	5	3.3.14 Defects in Printed and Formed Materials	11
2.3 National Electronic Manufacturers Association (NEMA)	5	3.3.15 Backfill Material	11
2.4 UL	5	3.3.16 Workmanship	12
3 REQUIREMENTS	6	3.4 Dimensional Requirements	12
3.1 General	6	3.4.1 Pattern Feature Accuracy	12
3.2 Materials	7	3.4.2 Bow and Twist (Rigid Areas and Applications) ..	12
3.2.1 Laminates and Bonding Materials	7	3.4.3 Flex	12
3.2.2 Other Dielectric Materials	7	3.4.4 Test Probe Dents	12
3.2.3 Metal Foils	7	3.4.5 Laser Trim	13
3.2.4 Metal Cores and Coins	7	3.4.6 Nicks and Pinholes	13
3.2.5 Surface Finishes, Coatings and Platings (Metallic and Nonmetallic)	7	3.5 Embedded Circuitry Dimensional Verification ..	13
		3.5.1 Spacing	13

3.6 Structural Integrity 13

3.6.1 Thermal Stress 13

3.6.2 Thermal Shock 13

3.6.3 Microsection Integrity 13

3.7 Electrical Requirements 13

3.7.1 Tolerance Requirements (Sheet-Based) 13

3.7.2 Dielectric Withstanding Voltage (Sheet-Based) . . . 13

3.7.3 Electrical Testing (Placed) 14

3.7.4 Circuitry 14

3.7.5 Moisture and Insulation Resistance (MIR)
(Sheet-Based and Formed) 14

3.8 Cleanliness 14

3.8.1 Placed, Soldered 14

3.9 Special Requirements 14

3.10 Rework and Repair 14

4 QUALITY ASSURANCE PROVISIONS 14

4.1 General 14

4.1.1 Qualification 14

4.1.2 Sample Test Coupons 17

4.2 Acceptance Tests 17

4.2.1 C=0 Zero Acceptance Number Sampling Plan . . 17

4.2.2 Referee Tests 17

APPENDIX A Index of Acronyms and Abbreviations . 18

Figures

Figure 1-1 Embedded Circuitry Device Categories 3

Figure 3-1 Foreign Object Debris (FOD) 10

Figure 3-2 Conductor Overlap 11

Tables

Table 3-1 Embedded Circuitry Test Requirements 6

Table 3-2 Maximum Limits of SnPb Solder
Bath Contaminant 10

Table 3-3 Edge Printed Board Contact Gap 10

Table 3-4 Tolerance Requirements (Sheet-Based) 13

Table 3-5 Dielectric Withstanding Voltages
(Sheet-Based) 14

Table 4-1 Acceptance Testing and Frequency 15

Table 4-2 C=0 Sampling Plan (Sample Size for
Specific Index Value) 17

Qualification and Performance Specification for Printed Boards Containing Embedded Active and Passive Circuitry

1 SCOPE

This specification covers qualification and performance of embedded active and passive circuitry within the finished printed board.

1.1 Purpose The purpose of this standard is to define the electrical, mechanical and environmental requirements specific to embedded passive and active circuitry. These requirements are in addition to the applicable requirements of other performance specification(s) (e.g., IPC-6010 series, J-STD-001). Where specified, the requirements in this specification may supersede those requirements.

Substrates, as pertain to this standard, are materials (e.g., prepreg, laminate, films, cores, etc.) that serve as a platform for the embedded circuitry.

See IPC-7092 for additional guidance and information on embedded circuitry.

1.2 Classification IPC standards recognize that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in manufacturability, complexity, functional performance requirements, and verification (inspection/test) frequency. It should be recognized that there may be overlaps of equipment between classes.

CLASS 1 General Electronic Products

Includes products suitable for applications where the major requirement is function of the completed assembly.

CLASS 2 Dedicated Service Electronic Products

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

CLASS 3 High Performance/Harsh Environment Electronic Products

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

1.3 Measurement Units All dimensions and tolerances in this specification are expressed in hard SI (metric) units. Users of this specification are expected to use metric dimensions. All dimensions ≥ 1.0 mm will be expressed in mm. All dimensions < 1.0 mm will be expressed in μm .

1.4 Definition of Requirements The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance.

The word “should” reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this Standard. The text takes precedence over the figures.

Where the word **shall** is used in this Standard, the requirements for each class are in brackets next to the requirement.

N = No requirement has been established for this Class

A = Acceptable

P = Process Indicator

D = Defect

Examples:

[A1P2D3] is Acceptable Class 1, Process Indicator Class 2 and Defect Class 3

[N1D2D3] is No requirement has been established Class 1, Defect Classes 2 and 3

[A1A2D3] is Acceptable Classes 1 and 2, Defect Class 3

[D1D2D3] is Defect for all Classes