



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-6016

Qualification and Performance Specification for High Density Interconnect (HDI) Layers or Boards

ANSI/IPC-6016

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A standard developed by IPC

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Qualification and Performance Specification for High Density Interconnect (HDI) Layers or Boards

Developed by the HDI Performance Subcommittee (D-43) of IPC

APPROVED AUGUST 31, 1999 BY



AMERICAN NATIONAL STANDARDS INSTITUTE

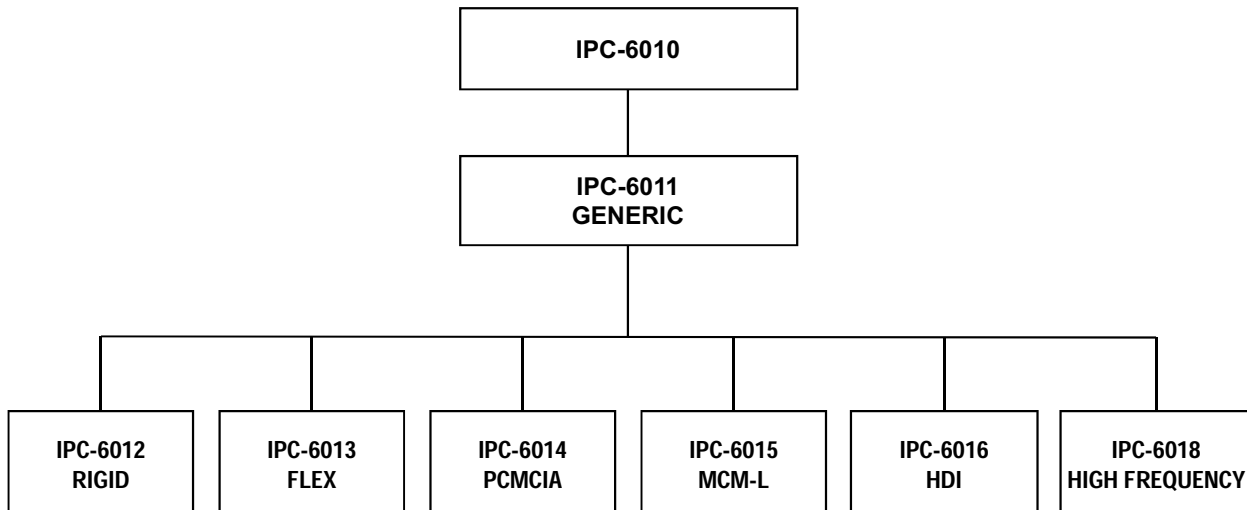
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HIERARCHY OF IPC QUALIFICATION AND PERFORMANCE SPECIFICATIONS (6010 SERIES)



FOREWORD

This specification is intended to provide information on the detailed performance criteria of High Density Interconnect layers only. The information contained herein supplements the generic requirements, identified in IPC-6011, as well as requirements relating to the core construction, identified in the sectionals: IPC-6012 (rigid), IPC-6013 (flex), IPC-6015 (MCM-L) or IPC-6018 (microwave). This document would be specified for and apply only to the added HDI features. The HDI layer should not modify most (if any) of the criteria set forth in the specification for the core construction. When used together, these documents should lead both manufacturer and customer to consistent terms of acceptability. If the HDI board does not employ a core construction, the customer should decide and specify which sectional performance specification should be used for evaluating criteria that is not covered in this document.

Within this document there are a number of performance criteria that are application dependent. These criteria are listed “slash sheets” in the back of the document that detail performance requirements based upon application. A blank slash sheet is also included to define needed requirements (agreed to by manufacturer and customer) for applications not currently covered.

NOTE: IPC-6016 was developed with consideration to HDI layers that use modified “conventional” plated-through hole processes and chemistries. The industry does not yet have enough experience to develop performance standards for HDI layers formed by novel processes that are drastically different from “conventional” plated-through hole constructions (i.e., non-plated copper processes). As experiences are gathered, criteria for these processes will be added. In the meantime, the customer and manufacturer should work together to set the criteria for acceptance of product using the new technologies.

IPC’s documentation strategy is to provide distinct documents that focus on specific aspects 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) (i.e., IPC-6010). The generic specification, the first document of the set, is supplemented by one or multiple sectional documents, each of which provide specific focus on one aspect of a topic or technology. IPC invites input on the effectiveness of the documentation and encourages user response through the “Standard Improvement Form” located at the back of each document.

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the HDI Performance Subcommittee (D-43) 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.

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Qualification and Performance Specification for High Density Interconnect (HDI) Layers or Boards

1 SCOPE

This specification establishes the specific requirements for organic high-density interconnect (HDI) layers with microvia technology and the quality and reliability assurance requirements that must be met for their acquisition.

1.1 Purpose The requirements contained herein are intended to reflect the electrical, mechanical, and environmental properties unique to the HDI layer. It is NOT intended to specify overall requirements for the core, which are already documented in the sectional performance specifications: IPC-6012 (rigid), IPC-6013 (flex), IPC-6015 (MCM-L), or IPC-6018 (microwave).

1.2 Performance Classification This specification recognizes HDI layers or boards will be subject to variations in performance requirements based on end use. The acceptance criteria of HDI layers are organized into slash sheet categories (A, B, C, etc., see Appendix A), which reflect those typical end-use applications. Users of this document **shall** select a slash sheet category that most closely resembles their product and are encouraged to modify it as necessary.

1.3 Slash Sheet Categories

- A. Chip Carrier
- B. Hand Held (cell phones, pagers)
- C. High Performance (avionics, military, medical)
- D. Harsh Environment (automotive, space)
- E. Portable (laptops, PDAs)

1.4 Documentation Hierarchy This document, combined with IPC-6011 and the applicable sectional performance specification(s) (IPC-6012, IPC-6013, IPC-6015 or IPC-6018), constitute a qualification and performance specification for HDI layers or boards.

2 APPLICABLE DOCUMENTS

The following specifications of the revision in effect at the time of order form a part of this document to the extent specified herein. If a conflict of requirements exists between IPC-6016 and the listed applicable documents, IPC-6016 **shall** take precedence.

2.1 IPC¹

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-PC-90 General Requirements for Implementation of Statistical Process Control

IPC-FC-231 Flexible Base Dielectrics for Use in Flexible Printed Wiring

IPC-FC-232 Adhesive Coated Dielectric Films for Use as Cover Sheets for Flexible Printed Wiring and Flexible Binding Films

IPC-FC-241 Flexible Metal-Clad Dielectrics for Use in Fabrication of Flexible Printed Wiring

IPC-AI-642 User's Guidelines for Automated Inspection of Artwork, Innerlayers, and Unpopulated PWBs

IPC-TM-650 Test Methods Manual²

- 2.1.1 Microsectioning
 - 2.1.1.2 Microsectioning—Semi or Automatic Technique Microsection Equipment (Alternate)
- 2.4.1 Adhesion, Tape Testing
- 2.4.8 Peel Strength of Metallic Clad Laminates
 - 2.4.21.1 Bond Strength, Surface Mount Lands Perpendicular Pull Method
 - 2.4.22 Bow and Twist
- 2.5.7 Dielectric Withstanding Voltage, PWB
- 2.6.3 Moisture and Insulation Resistance, Printed Boards
 - 2.6.7.2 Thermal Shock, Continuity and Microsection, Printed Boards
- 2.6.8 Thermal Stress, Plated-Through Holes
 - 2.6.8.1 Thermal Stress, Laminate
- 2.6.20 Assessment of Plastic Surface Mount Components for Susceptibility to Moisture/Reflow Induced Damage

IPC-ET-652 Guidelines and Requirements for Electrical Testing of Unpopulated Printed Boards

IPC-CC-830 Qualification and Performance of Electrical Insulating Compound for Printed Board Assemblies

1. IPC, 2215 Sanders Road, Northbrook, IL 60062-6135

2. For convenience, applicable test methods are reprinted in the back of this standard. They represent the latest method in effect at the time of publication. Test methods may be updated independent of standard revision. Users should check the IPC website (www.ipc.org) for the most current test methods available.

IPC-2221 Generic Standard on Printed Board Design

IPC-2226 Sectional Design Standard for Organic High Density Interconnect (HDI)

IPC-4101 Specification for Base Materials for Rigid and Multilayer Printed Boards

IPC-4104 Specification for High Density Interconnect (HDI) and Microvia Materials

IPC-6011 Generic Performance Specification for Printed Boards

IPC-6012 Qualification and Performance Specification for Rigid Printed Boards

IPC-6013 Qualification and Performance Specification for Flexible Printed Boards

IPC-6015 Qualification and Performance Specification for Organic Multichip Module (MCM-L) Mounting and Interconnecting Structures

IPC-6018 Microwave End Product Board Inspection and Test

IPC-7721 Repair and Modification of Printed Boards and Electronic Assemblies

2.2 Joint Industry Standards¹

J-STD-003 Solderability Tests for Printed Boards

3 REQUIREMENTS

3.1 General Printed boards with HDI layers furnished under this specification **shall** meet or exceed all of the requirements of this document and applicable slash sheet or as modified by the procurement documentation.

3.1.1 Terms and Definitions The definition of terms used herein **shall** be as specified in IPC-T-50 or as listed in 3.1.1.1 through 3.1.1.4.

3.1.1.1 Target Land The land on which the microvia ends and makes connection.

3.1.1.2 Capture Land The land where the microvia starts, and varies in shape and size based on use (i.e., component mounting, via entrance conductor, etc.)

3.1.1.3 Microvia Processed/plated hole ≤ 0.15 mm diameter (this specification can also be used for layers or boards where vias are > 0.15 mm diameter).

3.1.1.4 Core A single-sided, double-sided or multilayer board or flex circuit that is used as a carrier for HDI layers and meets the requirements of one of the following performance specifications: IPC-6012, IPC-6013, IPC-6015 or IPC-6018.

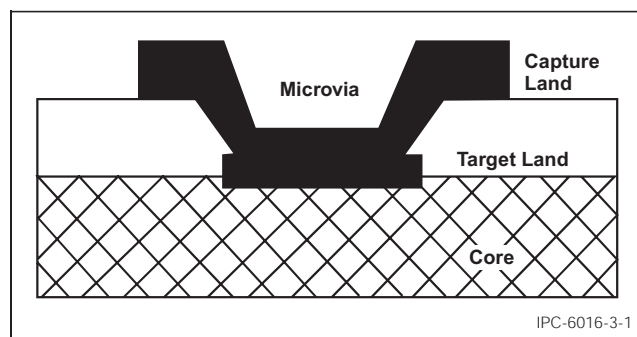


Figure 3-1 Typical Microvia Structure

3.2 Materials

3.2.1 Rigid Laminates Rigid reinforced laminates, clad and unclad, **shall** be as specified on the procurement documentation and **shall** be selected from IPC-4101 or IPC-4104. The type and metal thickness **shall** be as specified on the procurement documentation.

3.2.2 Flexible Films Flexible films, metal clad and unclad, **shall** be as specified on the procurement documentation and **shall** be selected from IPC-FC-231, IPC-FC-232 and IPC-FC-241. The type and metal thickness **shall** be as specified on the procurement documentation.

3.2.3 Bonding Materials Bonding materials **shall** be as specified on the procurement documentation and **shall** be selected from IPC-FC-232 and IPC-4101.

3.2.4 Other Dielectric and Conductive Materials Other materials **shall** be selected from IPC-4104 or as specified on the procurement documentation.

3.2.5 Metal Foils Metal foil materials **shall** be selected in accordance with the sectional performance specification for the applicable core board (i.e., IPC-6012 or IPC-6013).

3.2.6 Metallic Plating and Coatings The final circuit finish and other depositions **shall** be selected in accordance with and meet the requirements established in the applicable sectional performance specification (i.e., IPC-6012, IPC-6013, etc.). The minimum thickness of plated copper in the microvia **shall** be 10 μm . The minimum thickness of conductive material in microvias, which are formed and made conductive by a process that is significantly different from conventional plated-through hole constructions (i.e., non-plated copper processes), **shall** be as specified on the procurement documentation.



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3.2.7 Solder Resist Solder resist material **shall** be selected in accordance with the applicable sectional performance specification (i.e., IPC-6012, IPC-6013, etc.).

3.2.8 Marking Inks Marking inks **shall** be selected in accordance with the applicable sectional performance specification (i.e., IPC-6012, IPC-6013, etc.).

3.2.9 Hole Fill Material When required, the material used for hole fill **shall** be selected from IPC-4104 or as specified on the procurement documentation. Hole fill material **shall** provide a planar surface and survive performance testing as the product requires without lifting or cracking the dielectric layer.

3.3 Visual Examination Finished boards using HDI layers **shall** be examined in accordance with the following procedure. They **shall** be of uniform quality and **shall** conform to 3.3.1 through 3.3.7.

Visual examination of the circuits for applicable dimensional or workmanship attributes **shall** be conducted at 30X minimum.

3.3.1 Edges Nicks or halos on finished board edges **shall** be acceptable provided the penetration does not bridge adjacent conductors or reduce the spacing requirements below the minimum specified on the procurement documentation. Nonconductive burrs along the edges of the finished board **shall** be acceptable.

3.3.2 Surface Dielectric Imperfections Pits or surface voids are acceptable provided they do not bridge conductors or reduce the spacing requirements below the minimum specified on the procurement documentation.

Scratches, dents, or tool marks are acceptable provided they do not penetrate to a depth that reduces the dielectric thickness below the minimum specified on the procurement documentation.

3.3.3 Lifted Lands The finished HDI layer or board **shall not** exhibit any lifted lands.

3.3.4 Marking Markings **shall** be in accordance with the applicable sectional performance specification (i.e., IPC-6012, IPC-6013, etc.).

3.3.5 Solderability Solderability of surfaces **shall** be in accordance with the applicable sectional performance specification (i.e., IPC-6012, IPC-6013, etc.).

3.3.6 Adhesion

3.3.6.1 Metal to Metal Adhesion The adhesion of the plating **shall** be tested in accordance with IPC-TM-650, Method 2.4.1, using a strip of pressure sensitive tape

applied to the surface and removed by manual force applied perpendicular to the circuit pattern.

There **shall** be no evidence of any portion of the plating or the conductor pattern being removed, as shown by particles of the plating or pattern adhering to the tape. If overhanging metal breaks off (sliver) and adheres to the tape, this is not evidence of plating adhesion failure.

3.3.6.2 Metal to Dielectric Adhesion Peel strength testing **shall** be performed in accordance with IPC-TM-650, Method 2.4.8, if not supplied in the laminate certification. Type and frequency of test **shall** be specified on the procurement documentation. Peel strength **shall** meet the value specified on the applicable slash sheet.

3.3.6.3 Dielectric to Core Adhesion Thermal stress testing **shall** be performed in accordance with IPC-TM-650, Method 2.6.8.1. There **shall** be no evidence of delamination or blistering.

3.3.7 Workmanship HDI layers or boards **shall** be processed in such a manner as to be uniform in quality and show no visual evidence of dirt, foreign matter, oil, fingerprints, flux residue, and other contaminants that affect life, ability to assemble, and serviceability. Darkened appearance in non-plated holes, which is seen when the nonmetallic semi-conductive coating is used, is not foreign matter and does not affect life or function.

HDI layers or boards **shall** be free of defects in excess of those allowed in this specification. There **shall** be no evidence of any lifting or separation of platings from the surface of the conductive pattern, or of the conductor from the base laminate in excess of that allowed. There **shall** be no loose plating slivers on the surface of the HDI layer or board.

3.4 Dimensional Requirements All dimensional characteristics **shall** be as specified on the procurement documentation.

The accuracy, repeatability, and reproducibility of the equipment used to verify the characteristics of HDI layers or boards should be 10% or less of the tolerance range of the dimensions being verified. A measurement system evaluation **shall** be performed on each gauging system (see IPC-9191).

Automated inspection technology is allowed provided it meets requirements for repeatability (see IPC-AI-642).

3.4.1 Hole Pattern Accuracy The accuracy of the hole pattern on the HDI layer or board **shall** be as specified on the appropriate specification slash sheet.

3.4.2 Registration (Internal)

3.4.2.1 Microvia to Target Land Breakout at the target land is allowed up to 180°. Breakout at the target land is not allowed.