



IPC-4103A
with Amendment 1
2014 - January

**Specification for Base
Materials for High Speed/
High Frequency Applications**

Supersedes IPC-4103A
December 2011

A standard developed by IPC

Association Connecting Electronics Industries



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-4103A with Amendment 1

Specification for Base Materials for High Speed/ High Frequency Applications

Developed by the High Speed/High Frequency Base Materials Subcommittee (D-23) of the High Speed/High Frequency Committee (D-20) of IPC

IPC Standards and Artificial Intelligence (AI) Statement – 2025

IPC explicitly prohibits:

- The integration or transfer of any data whether in the form of IPC books, standards, metadata, or other formats — into AI engines or algorithms by any person or entity, including authorized distributors and their end users.
- Activities involving data harvesting, text and data mining, enrichment, or the creation of derivative works based on this data, including the use of automated data collection methods or artificial intelligence.

Any breach of these provisions is considered a copyright infringement unless expressly and formally authorized by IPC.

Supersedes:

IPC-4103A - December 2011
IPC-4103 - January 2002
IPC-L-125A - July 1992
IPC-L-125

This printing incorporates
modifications to noted errata.

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

This Page Intentionally Left Blank

Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the High Speed/High Frequency Base Materials Subcommittee (D-23) of the High Speed/High Frequency Committee (D-20) are shown below, it is not possible to include all of those who assisted in the evolution of this specification. To each of them, the members of the IPC extend their gratitude.

| High Speed/High Frequency Committee | High Speed/High Frequency Base Materials Subcommittee | Technical Liaison of the IPC Board of Directors |
|--|--|--|
| Chair Edward Sandor Taconic Advanced Dielectric Division | Chair Edward Sandor Taconic Advanced Dielectric Division | Bob Neves Microtek Laboratories |
| Vice-Chair Thomas N. Bresnan R&D Circuits | Vice-Chair Roy Keen Rockwell Collins | |
| <hr/> | | |
| High Speed/High Frequency Base Materials Subcommittee | | |
| James Baker-Jarvis, NIST | Patricia J. Goldman, P. J. Goldman Consulting | Joseph Schmidt, Raytheon Missile Systems |
| David Barrell, Isola Group | Jason Gretton, Panasonic Electric Works | Antonio R. Senese, Panasonic Electric Works |
| Silvio Bertling, Neltec, Inc. | Philip Henault, Raytheon Company | Lowell Sherman, Defense Supply Center Columbus |
| Michael Brandon, Isola Group SARL | Todd Henninger, DDi Corp. | Andy Slade, Rogers Corporation |
| Thomas N. Bresnan, R & D Circuits | Michael D. Janezic, NIST | Michael Smith, Arlon MED |
| Christine Coapman, Delphi Electronics and Safety | Thomas McCarthy, Taconic Advanced Dielectric Division | Steve J Vetter, NSWC Crane |
| John Coonrod, Rogers Corporation | Julio Mendoza, Isola Group SARL | Matthew Walsh, NSWC Crane |
| David J. Corbett, Defense Supply Center Columbus | Thomas Dale Murry, Rockwell Collins | Dan Welch, Arlon Materials for Electronics |
| Joseph Davis, Rogers Corporation | Christopher G. Olson, Rockwell Collins | David Wynants, Taconic Advanced Dielectric Division |
| Patricia S. Dupuis, Raytheon Company | Rolland D. Savage, High Performance Copper Foil Inc. | |
| Theodore Edwards, Dynaco Corp. | | |
| Mahendra S. Gandhi, Northrop Grumman Aerospace Systems | | |

This Page Intentionally Left Blank

Table of Contents

| | | | |
|--|---|---|----|
| 1 GENERAL | 1 | 3.1.6 Quality Assessment Data | 8 |
| 1.1 Scope | 1 | 3.1.7 Sample Qualification | 8 |
| 1.2 Type Designation | 1 | 3.1.8 Production Data | 8 |
| 1.2.1 Specification Sheets | 2 | 3.1.9 Customer Test Data | 8 |
| 1.2.2 Dielectric Permittivity Range | 2 | 3.1.10 Internal Assessment | 8 |
| 1.2.3 Dielectric Permittivity Tolerance | 2 | 3.1.11 Individual Customer Audit | 8 |
| 1.2.4 Nominal Laminate Thickness | 2 | 3.1.12 Independent Third Party Assessment | 8 |
| 1.2.5 Thickness Tolerance, Laminate | 2 | 3.2 Specification Sheets | 8 |
| 1.2.6 Metal Foil Indentations | 2 | 3.3 Manufacturers Quality Profile | 8 |
| 1.2.7 Metal Cladding Type and Nominal Weight or Thickness of Metal Cladding | 2 | 3.4 Qualification Testing | 8 |
| 1.2.8 Test Frequency | 4 | 3.5 Verification of Manufacturer's Quality System .. | 8 |
| 1.2.9 Dielectric Loss Tangent | 4 | 3.6 Conflict | 8 |
| 1.2.10 Resin | 4 | 3.7 Materials | 9 |
| 1.2.11 Filler | 4 | 3.7.1 Metal Cladding | 9 |
| 1.2.12 Reinforcement | 4 | 3.7.2 Reinforcement Fabric | 9 |
| 1.2.13 Bonding Layer Reinforcement Style | 4 | 3.7.3 Resin System | 9 |
| 1.2.14 Bonding Layer Parameters | 4 | 3.7.4 Fillers | 9 |
| 1.2.15 Color | 4 | 3.8 General Requirements/Acceptability | 9 |
| 1.3 Dimensions and Tolerances | 4 | 3.8.1 Fabricated Sheets and Panels | 9 |
| 1.4 Interpretation | 5 | 3.8.2 Inspection Lot | 9 |
| 1.5 Terms and Definitions | 5 | 3.8.3 Visual Properties | 10 |
| 1.5.1 As Agreed Between User and Supplier (AABUS) | 5 | 3.8.4 Dimensional | 12 |
| 1.7 Revision Level Changes | 5 | 3.9 Physical Requirements | 16 |
| 2 APPLICABLE DOCUMENTS | 5 | 3.9.1 Physical Requirements Laminate Materials .. | 16 |
| 2.1 IPC | 5 | 3.9.2 Physical Requirements, Bonding Layer Materials | 16 |
| 2.2 Joint Industry Standards | 6 | 3.10 Chemical Requirements | 17 |
| 2.3 National Conference of Standards Laboratories | 6 | 3.10.1 Chemical Requirements, Laminate | 17 |
| 2.4 Federal Specifications | 6 | 3.10.2 Chemical Requirements, Bonding Layer .. | 18 |
| 2.5 ASTM | 7 | 3.11 Electrical Requirements | 18 |
| 2.6 International Standards | 7 | 3.11.1 Electrical Requirements, Laminate | 18 |
| 2.7 MIL Specification | 7 | 3.12 Environmental Requirements | 19 |
| 2.8 International Electrotechnical Commission (IEC) | 7 | 3.12.1 Environmental Requirements, Laminate .. | 19 |
| 3 REQUIREMENTS | 7 | 3.12.2 Environmental Requirements, Bonding Layer .. | 19 |
| 3.1 General | 7 | 3.13 Visual and Dimensional Requirements, Laminates | 19 |
| 3.1.1 Qualification Assessment | 7 | 3.13.1 Substitutability of Grades of Metal Foil Indentations | 19 |
| 3.1.2 Quality Conformance Testing | 7 | 3.13.2 Substitutability of Classes of Thickness Tolerance | 19 |
| 3.1.3 Manufacturers Quality System | 7 | 3.13.3 Remarking of Substituted Laminates | 19 |
| 3.1.4 Process Control Testing | 7 | 3.14 Marking | 20 |
| 3.1.5 Self Declaration | 8 | 3.14.1 Marking, Laminates | 20 |
| | | 3.14.2 Marking Bonding Layer | 20 |

| | | | | | |
|----------|--|-----------|------------|--|----|
| 3.14.3 | Marking of Shipping Containers | 20 | 6.2.1 | Ordering Data for Laminate Material | 23 |
| 3.15 | Workmanship | 20 | 6.2.2 | Ordering Data for Bonding Layer Material | 24 |
| 3.16 | Material Safety | 20 | 6.3 | New Materials | 24 |
| 3.17 | Bonding Layer Shelf Life | 20 | | | |
| 4 | QUALITY ASSURANCE PROVISIONS | 21 | | Figures | |
| 4.1 | Quality System | 21 | Figure 3-1 | Thickness Measurement | 15 |
| 4.2 | Responsibility for Inspection | 21 | | | |
| 4.2.1 | Test Equipment and Inspection Facilities | 21 | | Tables | |
| 4.3 | Qualification Testing | 21 | Table 1-1 | Conventional Laminate Example | 1 |
| 4.3.1 | Samples | 21 | Table 1-2 | Enhanced Laminate Example | 1 |
| 4.3.2 | Frequency | 21 | Table 1-3 | Bonding Layer Example | 1 |
| 4.3.3 | Laminator Qualification Profile | 21 | Table 1-4 | Copper Foil Weights and Thickness (Taken From IPC-4562) | 3 |
| 4.3.4 | Changes in Composition | 21 | Table 1-5 | Bonding Layer Testing Parameters | 4 |
| 4.3.5 | Qualification Data Retention | 21 | Table 3-1 | Point Value System for Metal Foil Indentations | 10 |
| 4.4 | Quality Conformance Inspection | 21 | Table 3-2 | Permissible Variation in Length and Width of Laminates | 12 |
| 4.4.1 | Frequency | 21 | Table 3-3 | Reference Information and Testing Frequency of Laminates | 12 |
| 4.4.2 | Acceptance Criteria | 21 | Table 3-4 | Reference Information and Testing Frequency of Bonding Layer Material | 14 |
| 4.4.3 | Rejected Lots | 21 | Table 3-5 | Thickness Tolerance for Laminates in mm [in] | 15 |
| 4.4.4 | Conformance Data Retention | 22 | Table 3-6 | Laminate Bow and Twist, Maximum Percentage | 16 |
| 4.4.5 | Certificate of Conformance | 22 | Table 3-7 | Flammability Requirements | 17 |
| 4.5 | Statistical Process Control (SPC) | 22 | Table 3-8 | Dielectric Permittivity Tolerance | 18 |
| 5 | PREPARATION FOR DELIVERY | 23 | Table 4-1 | Quality Conformance Plan for Monthly, Quarterly and Annual Tests - Laminate | 22 |
| 5.1 | Packaging Materials | 23 | Table 4-2 | Quality Conformance Plan for Monthly, Quarterly and Annual Tests - Bonding Layer | 22 |
| 5.2 | Authorized Distributors | 23 | Table 6-1 | Summary of Legacy Specification Sheets | 25 |
| 6 | NOTES | 23 | Table 6-2 | Summary of IPC-4103A Specification Sheets .. | 25 |
| 6.1 | End User Responsibilities | 23 | | | |
| 6.1.1 | Background Information | 23 | | | |
| 6.1.2 | AABUS Rational | 23 | | | |
| 6.2 | Ordering Information | 23 | | | |