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IPC-4821

Specification for Embedded Passive Device Capacitor Materials for Rigid and Multilayer Printed Boards

IPC-4821

May 2006

A standard developed by IPC

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Developed by the Embedded Component Materials Subcommittee
(D-52) of the Embedded Components Committee (D-50) of IPC

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

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Foreword:

IPC-4821 was developed based on industry knowledge at the time. Embedded passive devices may be made with a large variety of materials and cover a wide range of fabrication processes. At the time of writing this specification, use of these materials was not widespread. As such, it is anticipated that updates to this document will be needed in the future. In the meantime, it is recommended that the customer and supplier work together to set the criteria for acceptance of embedded passive material products.

Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the Embedded Component Materials Subcommittee (D-52) 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.

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Specification for Embedded Passive Device Capacitor Materials for Rigid and Multilayer Printed Boards

1 SCOPE

This document describes materials that can be used for the fabrication of embedded passive capacitor devices within the finished printed circuit board substrate. For this document, embedded passive devices and the phrase embedded passives are considered to be equivalent. It provides information on general designations and associated characteristics of embedded passive device (EPD) capacitor materials. The document **shall** be used as a qualification and conformance standard for these materials.

This document contains material designation, conformance (requirements), qualification (characterization) and quality assurance specifications. IPC-4821 **shall** be used in conjunction with IPC-2000 series design standards and IPC-6000 series performance standards.

Embedded passive resistor material designation, conformance (requirements), qualification (characterization) and quality assurance specifications are contained in IPC-4811.

1.1 General This document covers the requirements for dielectric, conductive, and insulating materials that are used with materials for the manufacture of printed circuit boards containing embedded passive capacitor functionality. Figures 1-1a & 1-1b show representations of how embedded passives may appear in a PWB.

- Embedded passives are used to enhance high speed, high frequency performance.

- Embedded passives are used to increase circuit density and simplify design of circuitry features such as decoupling capacitance and terminating resistors.
- Embedded passives are used to simplify assembly by mounting fewer components, thereby increasing functionality and/or reducing total board area.

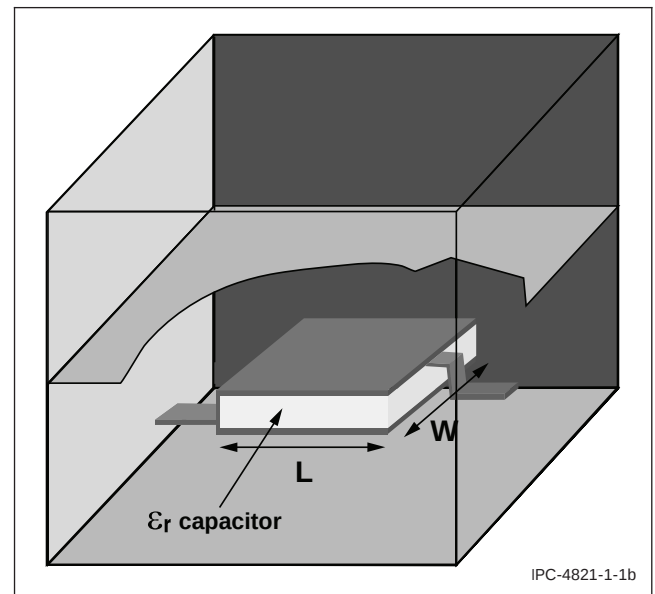


Figure 1-1b Embedded Discrete Capacitor Defined by Plate Size and Separating Dielectric

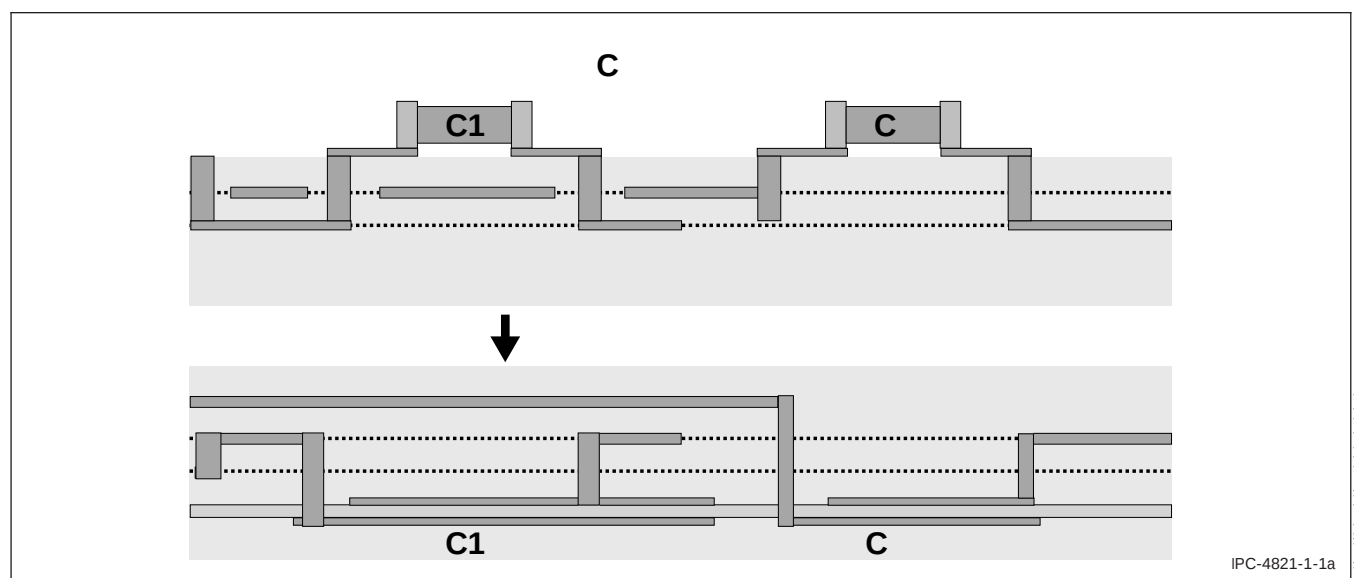


Figure 1-1a Embedded Planar Capacitor Saves Valuable Surface Real Estate

1.2 Designation System The following system identifies materials used for EPD structures. This is a general identification system and does not in any way imply that all the permutations of properties and forms exist. See the series of specification sheets at the end of this document for the specific materials available. Each specification sheet outlines engineering and performance data for materials that can be used to manufacture printed boards incorporating EPD capacitor materials. These materials include laminate, material applied to conductor foil and paste combinations. The specification sheets are provided with letters and numbers for identification and ordering purposes.

For example, a user wishing to order from specification sheet 1 would substitute the number “1” for the “S” in the designation examples (i.e., IPC-4821/1) shown in 1.2.1 through 1.2.3. To start the ordering process, one can use the specification sheets in this document in combination with relevant IPC documents for each material set (i.e., IPC-CF-148, IPC-4562, IPC-4101, or IPC-4104). Metal foils associated with an embedded passive material **shall** meet the requirements of IPC-4562 and the weight(s) of the foil(s) **shall** be specified on the purchase order.

The materials contained in this standard represent general material categories. As new materials become available, they will be added to future revisions. Users and material developers are encouraged to supply information on new materials for review by the IPC Embedded Passive Devices Materials Subcommittee (D-52). Users who wish to invoke this specification for materials not listed **shall** list a zero for the specification sheet number (IPC-4821/0).

The committee may approve new or revised specification sheets independent from revision of the document text. When this occurs, the new or revised specification sheet will be printed and made available through IPC-4821. The effective date of the new or revised sheet will be clearly indicated on the individual sheet.

Because there are embedded passive resistor and inductor materials specified in other documents, the designation system recognizes them by using a first level of designation as shown in Level 1 below.

The first level of the designation system is the Passive Device Type:

Level 1: Passive Device Type

Capacitor = C

Resistor = R

Inductor = L

For purposes of this specification, only “C” materials for Level 1 are included.

Table 1-1 illustrates the designation system for the capacitor passive device types. The remaining designation levels are listed in 1.2.1.

Note: The user's attention is called to the possibility that compliance with this standard may require use of inventions covered by rights of patents. By publication of this standard, no position is taken with respect to the validity of these claims or of any rights of patents in connection therewith. The patent holders have, however, filed a statement of willingness to grant a license under the rights of these patents on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from IPC.

1.2.1 Embedded Capacitor Passive Device Designations

Table 1-1 Sample Embedded Capacitor Passive Device Designation

IPC-4821	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
4821 / S	C	2	N	2	A	1/2	A
Where S is specification (slash) sheet number	Device Type	Form of Dielectric	Reinforcement	Chemistry	Filler	Conductor Type	Encapsulant

Example:

The sample from Table 1-1 will be written as
C 2 N 2 A 1/2 A.

Note: The letter “X” **shall** be entered into the designation where an item is not specified and does not matter.

Level 1: Passive Device Type: C

Level 2: Form of Dielectric:
Sheet = 1
Paste = 2
Liquid = 3
Other = 9

Level 3: Reinforcement:
Woven Glass = A
Nonwoven Matte Glass = B
Nonwoven Aramid fiber = C
None = N
Other = O

Level 4: Dielectric Chemistry (major constituent):
Epoxy = 1
Polyimide = 2
Polyester = 3
Ceramic = 4
Silicon Dioxide = 5
Metal Oxide = 6
Other = 9

Level 5: Filler (major constituent):

Barium Titanate = A
Other High K Ceramic = B
None = N
Other = O

Level 6: Conductor Type:

Conductive Layer #1:

Copper = 1
Sputtered Metal = 2
None = N
Other = 9

Conductive Layer #2:

Copper = 1
Sputtered Metal = 2
Copper Particle Paste = 3
Silver Particle Paste = 4
Other Particle Paste = 5
Transient Liquid Phase Sintering = 6
Organometallic = 7
Conductive Polymer = 8
None = N
Other = 9

Level 7: Encapsulant Chemistry:

Organic = A
Inorganic = B
Mixed = C
None = N

2 APPLICABLE DOCUMENTS

The following documents of the issue in effect at the time of order form a part of this specification to the extent specified herein. If a conflict exists between IPC-4821 and the listed applicable documents, IPC-4821 **shall** take precedence.

2.1 IPC¹

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

IPC-CF-148 Resin Coated Metal Foil for Printed Boards

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

IPC-TM-650 Test Methods Manual²

2.2.4 Dimensional Stability, Flexible Dielectric Materials

2.3.8.1 Flammability of Flexible Printed Wiring

2.3.9 Flammability of Prepreg and Thin Laminate

2.3.10 Flammability of Laminate

2.4.8 Peel Strength of Metallic Clad Laminates

2.4.9 Peel Strength, Flexible Dielectric Materials

2.4.13.1 Thermal Stress of Laminates

2.4.24.5 Glass Transition and Thermal Expansion of Materials Used in High Density Interconnection (HDI) and Microvias - TMA Method

2.4.25 Glass Transition Temperature and Cure Factor by DSC

2.4.39 Dimensional Stability, Glass Reinforced Thin Laminates

2.5.5.2 Dielectric Constant and Dissipation Factor of Printed Wiring Board Material - Clip Method

2.5.5.10 High Frequency Testing to Determine Permittivity and Loss Tangent of Embedded Passive Materials

2.5.17.1 Volume and Surface Resistivity of Dielectric Materials

2.5.17.2 Volume Resistivity of Conductive Materials Used in High Density Interconnection (HDI) and Microvias, Two-Wire Method

2.6.2.1 Water Absorption, Metal Clad Plastic Laminates

2.6.16.1 Moisture Resistance of High Density Interconnection (HDI) Materials Under High Temperature and Pressure (Pressure Vessel)

2.6.25 Conductive Anodic Filament (CAF) Resistance Test: X-Y Axis

IPC-QL-653 Certification of Facilities that Inspect/Test Printed Boards, Components and Materials

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

IPC-4562 Metal Foil for Printed Wiring Applications

IPC-4811 Specification for Embedded Passive Device Resistor Materials for Rigid and Multilayer Printed Boards

IPC-6012 Qualification and Performance Specification for Rigid Printed Boards

IPC-9191 General Requirements for Statistical Methods

2.2 American Society for Testing and Materials (ASTM)³

ASTM, Method D 149 "Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies"

2.3 Underwriters Laboratories (UL)⁴

UL 94 Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 746E Polymer Materials/Industrial Laminates Filament Wound Tubing, Vulcanized Fiber and Materials Used in Printed Wiring Boards

2.4 National Conference of Standards Laboratories (NCSL)⁵

ANSI/NCSL Z540-1 General Requirements for Calibration Laboratories and Measuring and Test Equipment.

2.5 International Organization for Standardization⁶

ISO 10012-1 Quality Assurance Requirements for Measuring Equipment, Part 1 - Metrological Confirmation System for Measuring Equipment

2.6 International Electrotechnical Commission⁷

IEC-6100-4-2 Human Body Model standard

1. www.ipc.org

2. Current and revised IPC Test Methods are available on the IPC website (www.ipc.org/html/testmethods.htm).

3. www.astm.org

4. www.ul.com

5. www.ansi.org

6. www.iso.org

7. www.iec.ch