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Requirements for Printed Electronics Base Materials (Substrates)

A standard developed by IPC

Association Connecting Electronics Industries



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Developed by the Printed Electronics Base Material/Substrates Subcommittee (D-62) of the Printed Electronics Committee (D-60) of IPC

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

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Acknowledgment

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Requirements for Printed Electronics Base Materials (Substrates)

1 SCOPE

1.1 Statement of Scope This standard establishes the classification system, the qualification and quality conformance requirements for printed electronics base materials (substrates).

The standard defines the base material only and should not be used for substrates that have been post processed and comprise defined features or structures e.g., conductive traces.

1.2 Purpose The purpose is to provide practitioners of printed electronics based products with the necessary technical structure to design and manufacture product meeting conformance to industry determined metrics.

1.3 Classification System The system described in 1.3.1 through 1.3.2.5 identifies printed electronics base materials.

1.3.1 Nonspecific Designation A nonspecific designation is intended for use by designers on master drawings to designate their base material choice. At the end of this standard is a series of base material specification sheets identified by specification sheet numbers. Each sheet outlines engineering and performance data for a printed electronics base material, indicating base material family classification e.g., ceramic, metal, organic or glass. The designer should select the appropriate base material specification sheet as required to meet the operational specifications of their application e.g., consumer, automotive, aerospace.

Example of nonspecific designation: IPC-4921/1, Where “1” refers to the specification sheet detailing unsupported polyethylene terephthalate base material.

If further material specification details (such as thickness) are required, they should be highlighted in cross sectional views or notes on the master drawing.

1.3.2 Specific Designation The specific designation should be in the form shown in the following example, and is intended for use on material purchase orders by fabricators (see Section 6). The specific designation should not be used by designers on master drawings to indicate their material selection. Designers **shall** specify on master drawings their material selection, as the specific designation is lengthy and requires fabricator level knowledge in making the detailed selections.

Example of specific designation:

IPC-4921/1 – OR7/1/F/7

Where:

IPC-4921/1 – Nonspecific Designation (see 1.3.1), for unsupported polyester base material.

OR7 – Base Material Type Designation (see 1.3.2.2), specifying polyethylene terephthalate.

1 – Base Structure Designation (see 1.3.2.3), specifying film.

F – Reinforcement Type Designation (see 1.3.2.4), specifying non-reinforced.

7 – Base Material Thickness Designation (see 1.3.2.5), specifying thickness ≥ 0.250 mm.

1.3.2.1 Base Material Family The family of the printed electronics base material **shall** be designated per Table 1-1.

Table 1-1 Base Material Family Designation

Designation	Family
C	Ceramic
M	Metal
OR	Organic
G	Glass
O	Other

1.3.2.2 Base Material Type The type of printed electronics base material **shall** be designated per Table 1-2.

Table 1-2 Base Material Type Designation

Designation	Base Type
C1	Alumina
C2	Aluminum Nitride
CO	Other ceramic
M1	Aluminum
M2	Copper
M3	Copper-tungsten
M4	Stainless Steel
MO	Other metal
OR1	Biaxially Oriented Polypropylene
OR2	Epoxy
OR3	Fluorinated Ethylene-propylene
OR4	Polycarbonate
OR5	Polyetheretherketone
OR6	Polyethylene naphthalate
OR7	Polyethylene terephthalate
OR8	Polyethylene tetrafluoroethylene
OR9	Polyetherimide
OR10	Polyimide
OR11	Polytetrafluoroethylene
OR12	Polyvinyl chloride
OR13	Silicone
ORO	Other organic
G	Borosilicate (alkali-free) glass
GO	Other glass

1.3.2.3 Base Structure The base structure **shall** be designated per Table 1-3.

Table 1-3 Base Structure Designation

Designation	Base Structure
1	Film
2	Sheet
3	Composite - Woven
4	Composite - Nonwoven e.g., fillers
5	Other

1.3.2.4 Base Reinforcement Type The base reinforcement type **shall** be designated per Table 1-4.

Table 1-4 Base Reinforcement Type Designation

Designation	Base Reinforcement Type
A	Ceramic
B	Metal
C	Organic
D	Glass
E	Composite
F	Non-reinforced

1.3.2.5 Base Material Thickness The base material thickness **shall** be designated per Table 1-5.

Table 1-5 Nominal Base Material Thickness Designation

Designation	Base Reinforcement Type
1	Thickness <0.020 mm [Thickness <787 µin]
2	0.020 mm ≤ Thickness <0.025 mm [787 µin ≤ Thickness <984 µin]
3	0.025 mm ≤ Thickness <0.075 mm [984 µin ≤ Thickness <2953 µin]
4	0.075 mm ≤ Thickness <0.100 mm [2953 µin ≤ Thickness <3937 µin]
5	0.100 mm ≤ Thickness <0.150 mm [3937 µin ≤ Thickness <5906 µin]
6	0.150 mm ≤ Thickness <0.250 mm [5906 µin ≤ Thickness <9843 µin]
7	Thickness ≥0.250 mm [Thickness ≥9843 µin]
X	Specified in document

1.4 Surface Treatments This specification recognizes that printed electronics base materials may be subjected to various surface treatments to improve wetting and adhesion by the functional material. Additionally, these treatments may provide functionality such as gas barrier, liquid barrier, or planarization. Example treatments are provided in Table 1-6.

Table 1-6 Surface Treatments

Chemical	Mechanical	Coating
Acid etched	Sandblasting	Acrylic primer
Alkali etched	Supercalendering	Epoxy primer
Anodic oxide	Other	Silicone primer
Corona		Other
Plasma		
Other		

1.5 Manufacturing Temperature Classification This specification recognizes that printed electronics base materials will be subjected to different processing temperature conditions during manufacturing of the printed electronics product. Below are listed the manufacturing classifications.

Class 1 – 0°C to 50°C*

Class 2 – 50°C to 125°C*

Class 3 – 125°C to 200°C*

Class 4 – 200°C to 250°C*

Class 5 – 250°C to 300°C*

Class 6 – Above 300°C

*Maximum dwell time(s) at temperature extremes **shall** be AABUS.

1.6 Qualification The printed electronics base materials that meet all the related requirements of this standard **shall** be qualified products (see 4.8).

1.7 Quality Conformance This standard establishes a quality conformance system for the suppliers to demonstrate the continual conformance of the printed electronics base material to the quality requirements of the standard. See 4.9 for quality conformance inspection requirements.

1.8 Procurement Documentation The procurement documentation **shall** provide sufficient information to the supplier so that the supplier can fabricate the printed electronics base material and ensure that the user receives the desired product. The procurement documentation should specify the requirements that can be selected from within this standard.

1.9 Material Characteristics The printed electronics base materials made to this standard use established requirements to enable the material to be applied in a broad range of applications. The printed electronics base materials made to this standard may have characteristics that provide specific enhanced performance e.g., oxygen/moisture permeability, etc.

user and supplier should review these enhancements. These enhancements may meet or exceed the specification requirements and will be as designated in the purchasing documentation (AABUS, see 1.9.1).

1.9.1 As Agreed Upon Between User and Supplier (AABUS) Indicates additional or alternate requirements to be decided between the user and the supplier in the procurement documentation. Examples include contractual requirements, modifications to purchase documentation and information on the drawing. Agreements can be used to define test methods, conditions, frequencies, categories or acceptance criteria within a test, if not already established.

1.10 New Materials The printed electronics base materials contained in this standard represents known materials. As new materials become available, they will be added to future revisions. Users and material developers are encouraged to supply information on new printed electronics base materials using the blank specification sheet at the end of this standard for review by the IPC Printed Electronics Base Material/Substrates Subcommittee (D-62). Users who wish to invoke this standard for printed electronics base materials not listed **shall** list a zero for the specification sheet number (i.e., IPC-4921/0).

1.11 Interpretation “Shall” The imperative form of the verb is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a “**shall**” requirement may be considered if sufficient data is supplied to justify the exception.

The words “should” and “may” are used whenever it is necessary to express nonmandatory provisions.

“Will” is used to express a declaration of purpose. To assist the reader, the word “**shall**” is presented in bold characters.

1.12 Presentation All dimensions and tolerances in this specification are expressed in hard SI (metric) units and parenthetical soft imperial (inch) units. Users of this specification are expected to use metric dimensions. All dimensions greater than or equal to 1.0 mm [0.0394 in] will be expressed in millimeters and inches. All dimensions less than 1.0 mm [0.0394 in] will be expressed in micrometers and microinches.

2 APPLICABLE DOCUMENTS

The following documents of the issue currently in effect form a part of this standard to the extent specified herein.

2.1 IPC¹

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

IPC-TM-650 Test Methods Manual²

- 2.1.13 Inspection for Inclusions and Voids in Flexible Printed Wiring Materials
- 2.2.4 Dimensional Stability, Flexible Dielectric Materials
- 2.3.2 Chemical Resistance of Flexible Printed Wiring Materials
- 2.3.38 Surface Organic Contaminant Detection Test
- 2.3.39 Surface Organic Contaminant Identification Test
- 2.4.16 Initiation Tear Strength, Flexible Insulating Materials
- 2.4.17.1 Propagation Tear Strength, Flexible Insulating Material
- 2.4.18.3 Tensile Strength, Elongation, and Modulus
- 2.4.19 Tensile Strength and Elongation, Flexible Printed Wiring Materials
- 2.4.24 Glass Transition Temperature and Z-Axis Thermal Expansion by TMA
- 2.5.5.3 Permittivity (Dielectric Constant) and Loss Tangent (Dissipation Factor) of Materials (Two Fluid Cell Method)
- 2.5.5.5 Stripline Test Method for Permittivity and Loss Tangent (Dielectric Constant and Dissipation Factor) at X-Band
- 2.5.5.9 Permittivity and Loss Tangent, Parallel Plate, 1 MHz to 1.5 GHz
- 2.5.17 Volume Resistivity and Surface Resistance of Printed Wiring Materials
- 2.6.1 Fungus Resistance Printed Wiring Materials
- 2.6.2 Moisture Absorption, Flexible Printed Wiring

1. www.ipc.org

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