



*The Institute for
Interconnecting
and Packaging
Electronic Circuits*

IPC-TF-870

Qualification and Performance of Polymer Thick Film Printed Boards

ANSI/IPC-TF-870

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A standard developed by the Institute for Interconnecting
and Packaging Electronic Circuits

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- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feed back system on use and problems for future improvement

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The material in this standard was developed by the Polymer Thick Film Task Group of the Hybrid & Related Technologies Committee of the Institute for Interconnecting and Packaging Electronic Circuits.



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

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Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principle members of the IPC

Polymer Thick Film Task Group of the IPC Hybrid & Related Technologies Committee 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 of Polymer Thick Film Printed Boards

1.0 SCOPE

This specification covers the materials, qualification, certification, and performance requirements for multilayer Polymer Thick Film (PTF) printed, extrusion deposited, or otherwise applied conductor, insulator, and through-hole technology. Printed, extrusion deposited, or otherwise applied circuitry, shall meet all applicable requirements of this specification and the master drawing. Etched and plated conventional printed circuits may also be an integral part of this technology. This specification may also be used for procurement of single-sided and double-sided boards. See Figures 1, 2, and 3.

1.1 Construction Printed boards shall be of the types shown as specified:

- Construction 1A* Single-Sided Board (Rigid)
- Construction 1B* Single-Sided Board (Flex)
- Construction 2B* Double-Sided Board (Rigid)
- Construction 2B* Double-Sided Board (Flex)
- Construction 3* Multilayer Board

1.1.1 Classes This specification provides Classes (1, 2, and 3) for feature requirements to reflect progressive increases in sophistication, functional performance requirements and testing severity. The reference of a single class does not preclude working, invoking or allowing specific requirements defined in other classes.

Class 1—Consumer Products (Includes TV sets, toys, entertainment electronic and non-critical or industrial control devices).

Class 2—General Industrial (Includes computers, telecommunication equipment, sophisticated business machines, instruments and certain non-critical military applications).

Note: Reliability required in high humidity conditions should be considered.

Class 3—High Reliability (Includes that equipment where continued performance is critical, equipment downtime cannot be tolerated or the equipment is a life support item).

Note: Unless otherwise specified, Class 3 shall be used for military electronic equipment.

2.0 APPLICABLE DOCUMENTS

2.1 IPC¹

IPC-T-50 Terms and Definitions

IPC-CF-150 Copper Foil For Printed Wiring Applications

IPC-FC-250 Standard for Single- and Double- Sided Flexible Wiring with Interconnections

IPC-D-300 Printed Board Dimension and Tolerances

IPC-S-815 General Requirements for Soldering Electronic Interconnections

IPC-SF-818 General Requirements for Electronic Soldering Fluxes

IPC-SM-840 Qualification and Performance of Permanent Polymer Coating (Solder Mask) for Printed Boards

IPC-ML-950 Performance Specifications for Multilayer Printed Wiring Boards

IPC-TM-650² Test Methods Manual

2.1.1 Microsectioning

2.3.23 Solder Mask Cure (Permanency) Thermally Cured Masks

2.3.38 Surface Organic Contaminant Detection Test (In-House Method)

2.4.22 Bow and Twist

2.4.27.2 Solder Mask Abrasion (Pencil Method)

2.4.28 Adhesion, Solder Mask (Non-Wetting Metals)

2.4.28.1 Adhesion, Solder Mask (Melting Materials)

2.4.29 Adhesion, Solder Mask Flexible Circuits

2.4.36 Rework Simulation, Plated-Through Holes

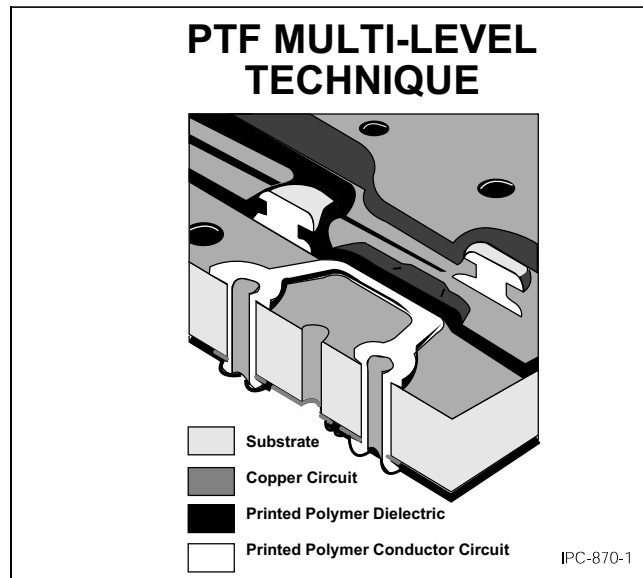
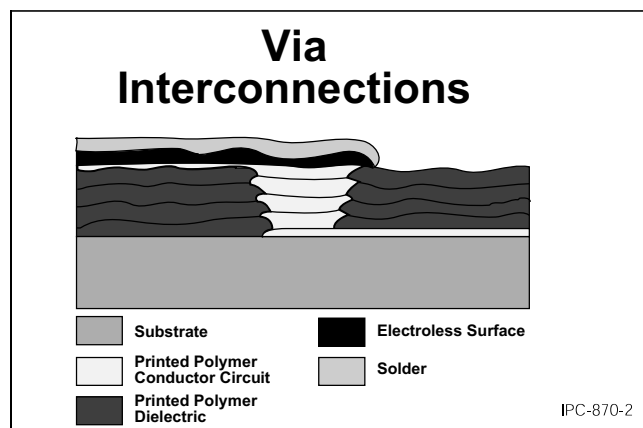
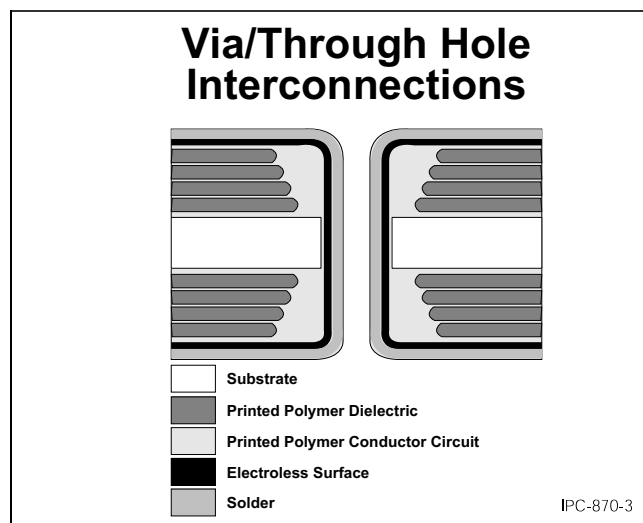
2.5.6.1 Dielectric Strength, Polymer Solder Mask, and/or Conformal Coatings

2.6.1 Fungus Resistance Printed Wiring Materials

1. Publications are available from the IPC, 2215 Sanders Road, Northbrook, IL 60062-6135

2. For convenience, reprints of the IPC-TM-650 Test Methods are provided at the end of this specification.



INTERCONNECTION VIAS**Figure 1****Figure 2****Figure 3**

2.6.3 Moisture and Insulation Resistance, Rigid, Rigid/Flex and Flex Printed Wiring Boards

2.6.7 Thermal Shock and Continuity (Flexible Printed Wiring)

2.6.11 Hydrolytic Stability Solder Mask and conformal coatings

2.3.31 Relative Degree of Cure in U.V. Curable Materials

2.6.3.2 Moisture and Insulation Resistance, Flexible Printed Wiring

2.6.14 Resistance to Electromigration, Polymer Solder Mask

IPC-FC-231B Flexible Bare Dielectrics for Use in Flexible Printed Wiring

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

IPC-FC-233A Specification for Flexible Adhesive Bonding Films

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

IPC-S-804A Solderability Test Methods for Printed Wiring Boards

2.2 Government³

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

MIL-T-10727 Tin Plating, Electrodeposited or Hot Oil Dipped, for Ferrous and Nonferrous Metals

MIL-C-14550 Copper Plating (Electrodeposited)

MIL-I-43553 Marking Inks

MIL-G-45204 Gold Plating, Electrodeposited

MIL-I-45208 Inspection Systems Requirements

MIL-F-14256 Flux, Soldering, Liquid (Rosin Base)

MIL-P-81728 Plating, Tin-Lead (Electrodeposited)

2.3 Federal

QQ-N-290 Nickel Plating

QQ-S-571 Solder, Lead Alloy, Tin Lead & Tin Alloy, Flux Cored Ribbon and Wire, and Solid Form

3.0 Requirements

3.1 General Requirements The design features of the board shall be in accordance with the approved master drawing and this specification. In the event of conflict the master drawing shall govern.

3.2 Terms and Definitions The definitions of all terms used herein shall be as listed below and as specified in IPC-T-50 and IPC-SM-840.

3.2.1 Polymer Thick Film A polymer thick film printed board is an organic resin-based system of conductive, resistive or insulative materials applied to a substrate and cured.

3.2.2 Polymer Additive Process Any combination of polymer applications including conductors, insulators, resistors or inductors that serve the purpose of creating an electronic circuit and/or electronic components (capacitors, switches, potentiometers, resistors, jumpers, etc.).

3.2.3 Polymer Conductor PTF material(s) applied in some manner so as to provide the basic circuit for a printed board or a modification to a basic circuit. Such a material is compounded with conductive particles, thermoplastic and/or curable polymers and additives.

3.2.4 Polymer Dielectric PTF material(s) applied in some manner which exhibits a dielectric constant high enough to form capacitance of acceptable levels between two electrodes.

3.2.5 Polymer Insulator PTF material(s) applied in some manner which exhibits a high enough voltage breakdown to serve as an electrical barrier.

3.2.6 Polymer Element PTF material(s) applied in some manner so as to serve as an element in the electrical design, such as a resistor, capacitor, inductor, jumper, etc.

3.2.7 Polymer Via An interconnection point between layers of circuitry separated by an applied polymer insulative layer. The via consists of the polymer conductive material connecting the layers of circuitry and the insulative material surrounding it. (See Figure 4).

3.2.8 Polymer Conformal Coating PTF insulative material(s) applied in some manner to provide physical insulation and chemical protection to the surface of an electrical circuit.

3.2.9 Voids Any absence of PTF material that results in a deterioration in the electrical properties of the circuit or gives the appearance of poor workmanship.

3.2.10 Unsupported Hole A functional hole in the circuit made conductive with PTF materials and having no metal support.

3.3 Materials The types of materials shall be as specified herein and on the master drawing. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.3.1 Rigid Substrates Typical circuit board material is often used as the substrate. Copper-clad etched circuits may also be employed. Ceramic, coated metal, and a variety of molded plastics have also been used. Rigid substrate type shall be as defined in the master drawing.

3.3.2 Flexible Substrates Flexible substrates when required shall conform to IPC-FC-231, IPC-FC-232, IPC-FC-233, and IPC-FC-241.

3.3.3 Polymer Element Polymer elements shall be capable of performing the functions of the desired component (such as resistor, capacitor, inductor, or jumper connection) as required in this document and as specified in the master drawing; and shall continue to perform these functions when subjected to applicable tests.

3.3.4 Electroless Metallic Coatings A metal layer added to electroless deposition to printed polymer materials to form conductive circuitry.

3.3.5 Electrodeposited Metals A metallic layer added on top of a polymer print using electroplating techniques.

3.3.5.1 Electrodeposited Copper All electrodeposited copper shall meet the requirements of MIL-C-14550.

3.3.5.2 Electrodeposited Tin-Lead All electrodeposited tin-lead shall meet the requirements of MIL-P-81728.

3.3.5.3 Electrodeposited Tin Tin plating shall be in accordance with Type I (electrodeposited) or Type II (hot dipped) of MIL-T-10727, or as specified by the master drawing.

3.3.5.4 Electrodeposited Nickel All electrodeposited nickel shall meet the requirements of QQ-N-290.

3.3.5.5 Electrodeposited Gold All electrodeposited gold shall meet the requirements of MIL-G-45204.

3.3.6 Copper Foil All copper foil shall meet the requirements of IPC-CF-150 and the master drawing.

3.3.7 Shielding Shielding materials (silver epoxy, vapor depositions, etc.) when required shall be as agreed upon between user and vendor.

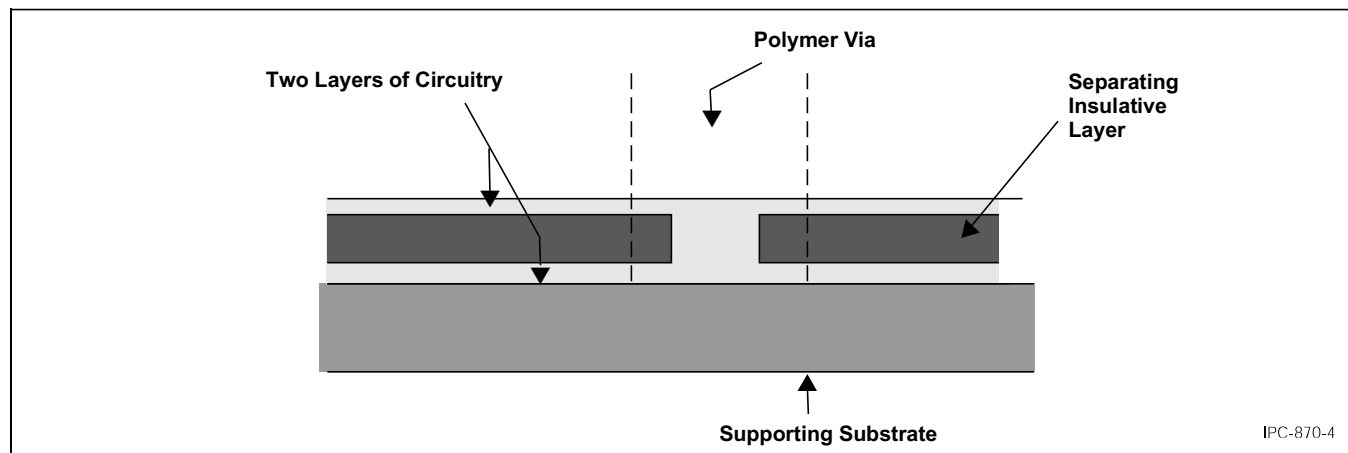


Figure 4

3.3.8 Solder The solder used shall be in accordance with composition Sn60, Sn62, or Sn63 of QQ-S-571. For wave or dip soldering, use bar solder form B. For hand soldering, use solder wire form W, either solid metal type S, or with a core of flux of either type R, RMA of QQ-S-571. As agreed upon between user and vendor, solder paste when used shall meet the reliability, test and reflow requirements of IPC-S-815.

3.3.9 Solder Flux Solder flux used shall be flux per IPC-SF-818, Type L or M. H type flux shall not be used unless agreed upon by user and vendor.

3.3.10 Solder Mask When permanent polymer solder mask is specified on the master drawing, it shall meet the requirements of IPC-SM-840 for the class specified.

3.3.11 Marking Ink Marking ink shall conform to MIL-I-43553.

3.4 Visual Examination The boards shall be examined to verify that the design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements in this specification, and the master drawing. Features of the board shall be measured at 3X. Referee magnification of board features shall be 10X.

3.4.1 Subsurface Imperfections Laminate voids shall meet the requirements of IPC-ML-950. The class of defect shall be as defined on the master drawing.

3.4.2 Foreign Inclusions Foreign inclusions shall be permitted when they are identified as non-conductive, or are located at least 0.25 mm [0.010 inch] from the nearest conductor. If located between conductors the foreign inclusion shall be permitted if there is more than 50% space remaining. The longest dimension of an allowable foreign inclusion shall be no greater than 8.128 mm [0.32 inch] in non-circuitry areas.

3.4.3 Discoloration Surface and subsurface nonconductive stains and discolorations in the substrate material shall be acceptable as agreed upon between user and vendor.

3.4.4 Delamination/Blisters Delamination/Blisters shall be evaluated in accordance with IPC-ML-950.

3.4.5 Measles Measles shall be in accordance with IPC-ML-950.

3.5 Dimensional Requirements

3.5.1 Dimensions When tested in accordance with 4.6.1.1, the finished printed wiring board shall meet the dimensional requirements specified here and on the master drawing. (See 6.3).

3.5.2 Hole Accuracy The accuracy of the hole pattern on the boards shall be as specified on the master drawing.

3.5.3 Bow and Twist When tested in accordance with 4.6.1.2, the maximum bow and twist shall be in accordance with IPC-D-300.

3.5.4 Conductor Spacing The conductor spacing on the board shall be as specified on the master drawing.

3.5.5 Conductor Width The minimum conductor width shall be as specified on the master drawing.

3.5.6 Conductor Thickness The finished conductor thickness shall measure as specified at any point on the surface or inside a hole.

3.5.7 Conductor Pattern and Edges Conductor patterns shall have no tears or cracks.

3.5.8 Annular Ring When tested in accordance with 4.6.1.3, the minimum annular ring shall be 0.127 mm [0.005 inch] for external pads and 0.0762 mm [0.003 inch] internal pads.

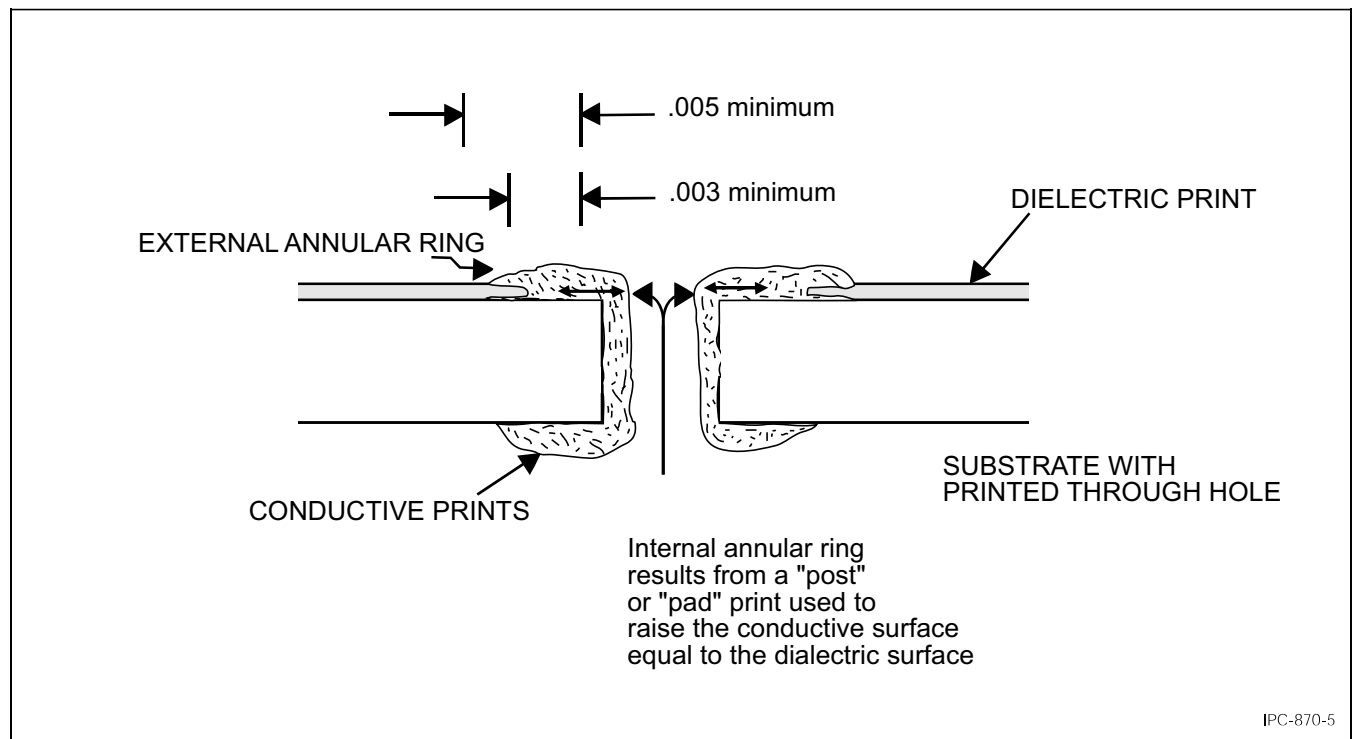


Figure 5

3.5.9 Polymer Dielectric Thickness When tested in accordance with 4.6.1.1.2, the minimum dielectric thickness, (closest points between conductors), shall be as specified on the master drawing.

3.5.10 Layer to Layer Registration When tested in accordance with 4.6.1.4, the layer-to-layer registration shall not exceed 20% of the conductor width.

3.6 Physical Requirements

3.6.1 Pencil Hardness When tested as specified in 4.6.2.1, all portions of polymer thick film system shall not be scratched by a pencil which is softer than the hardness shown in Table 1. (See 6.4)

Table 1

Hardness	Classification
2H	Soft
4H	Medium
6H	Hard

3.6.2 Scratches/Gouges Scratches and gouges shall be permitted when conductor width is not reduced by more than 20% and the depth does not exceed 5 microns.

3.6.3 Adhesion The following paragraphs provide requirements for testing adhesion of polymer thick film to rigid or flexible substrates. Only those requirements neces-

sary to evaluate material to a particular application need be imposed.

3.6.3.1 Adhesion to Rigid Printed Wiring Unless otherwise specified, the maximum percentage of polymer lifted from the surface of the base material, conductors, and lands of the coated printed board, shall not be more than 10% of the cross-hatched area.

3.6.4 Hole Solderability When component attachment holes or holes intended to be solderable are tested as specified in 4.6.2.3, they shall exhibit proper wetting of the wall, the printed-through hole and the associated land area. For holes other than these, there is no solderability requirements.

3.6.5 Surface Solderability When tested in accordance to 4.6.2.4, and as agreed to between user and vendor, the areas indicated shall be solderable.

3.6.6 Through-Hole Examination (Microsection) After Thermal Shock When examined in accordance with 4.6.1.1, the holes shall exhibit no cracking of the printed through-hole or conductor patterns and no blistering, meandering, or delamination beyond that which is allowed in IPC-ML-950. The walls shall be covered and shall extend outward completely around the hole wetting the terminal area. Minimum conductor thickness specification shall apply to thickness of conductor walls in the barrel.

3.6.7 Bond Strength, Unsupported When the