Qualification and Performance of Permanent Solder Mask
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Standards Should:
- Show relationship to DFM & 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

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The material in this standard was developed by the IPC-SM-840 Task Group (5-33b) of the Cleaning and Coating Committee (5-30) of the Institute for Interconnecting and Packaging Electronic Circuits.
Qualification and Performance of Permanent Solder Mask

Developed by the IPC-SM-840C Task Group of the Cleaning and Coating Committee of the Institute for Interconnecting and Packaging Electronic Circuits

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 Soldermask Performance Task Group (5-33b) of the IPC Cleaning and Coating 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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1.0 SCOPE AND DESIGNATION

1.1 Scope  This standard has been designed and constructed with the intent of obtaining the maximum information about and confidence in the solder mask material under evaluation with the minimum of test redundancy. (See 6.1)

This standard covers:

— The evaluation and conformance of permanent solder mask material properties (Table 1, Column A).
— The qualification of the solder mask/standard IPC-B-25A test board (Table 1, Column B).
— The qualification assessment of the solder mask/production board process (Table 1, Column C).

For purposes of this specification, the term “solder mask” is used herein when referring to any type of permanent polymer coating material applied prior to assembly, but excluding marking (legend) inks and temporary hole plugging materials.

1.2 Purpose  This standard enables a vendor to evaluate solder mask, and express the characteristics it possesses, when tested in a standard board system according to the test methods and conditions contained in this document. It also enables a printed board designer, manufacturer, and/or user to jointly qualify a production board process using the test methods and conditions contained in this document based on end use and environmental reliability requirements. Quality conformance of production boards shall be evaluated in accordance with IPC-RB-276.

The materials described herein are intended for use on printed boards in order to provide a solder mask to prevent solder bridging, and/or for the retardation of electromigration and other forms of conductive growth, and/or for the physical protection of the printed board.

This specification does not determine the compatibility of solder mask materials with post soldering products and processes. The determination of this compatibility is the responsibility of the board fabricator/board user. The test procedures specified herein may be useful tools to determine this compatibility.

Solder mask materials covered in the standard are not intended for use as a substitute for conformal coatings that are applied after assembly to cover components, component leads/terminations and solder connections.

This document lists the base requirements for solder mask and solder mask production board process. Additional requirements can be required as agreed upon between the solder mask vendor and the board fabricator, or between the board fabricator and end user.

This document assumes that the mask is processed and cured per the manufacturer’s recommended process. The curing of the solder mask material that has been applied to printed boards shall be in accordance with those conditions specified by the solder mask vendor for that product or a qualified alternate method as agreed to between the board fabricator and the end user. When (other) alternate methods are used, the board fabricator has full responsibility for the performance of the solder mask.

1.3 Classes  This specification provides classes of requirements to reflect functional performance requirements and testing severity based on industry/end use requirements.

Note: The reference of a single class does not preclude invoking or allowing specific requirements defined in other classes.

T — Telecommunication (Includes computers, telecommunication equipment, sophisticated business machines, instruments, and certain non-critical military applications.) Solder mask on boards in this class is suitable for high performance commercial and industrial products in which extended performance life is required but for which interrupted service is not life threatening.

H — High Reliability/Military (Includes that equipment where continued performance is critical, equipment down-time cannot be tolerated and/or the equipment is a life support item.) Solder mask on boards of this class is suitable for applications where high levels of assurance are required and uninterrupted service is essential.

Note: Class Designations - Previous versions of this specification, and other IPC documents, make reference to “Class 1”, “Class 2”, and “Class 3”. For all practical purposes there is no Class 1 solder mask. Class 2 is equivalent to Class T (Telecommunications). Class 3 is the equivalent of Class H (Military/high reliability).

1.4 Presentation  Dimensions and tolerances are expressed in metric units, with English units shown in brackets [ ]. and are not necessarily direct conversions in order to provide usable numbers. Users are cautioned to
employ a single system and to not intermix millimeters and inches. Reference information is shown in parentheses ( ).

2.0 APPLICABLE DOCUMENTS
The following documents of issue currently in effect form a part of this specification to the extent specified herein.

2.1 IPC

IPC-A-25A Multipurpose Test Board Artwork Films
IPC-B-25A Master Drawing Master Drawing, Multipurpose Test Board
IPC-T-50 Terms and Definitions
IPC-RB-276 Qualification and Performance of Rigid Printed Boards
  TM 2.1.1 Microsectioning
  TM 2.3.23 Cure (Permanency) Thermally Cured Solder Masks
  TM 2.3.23.1 Cure (Permanency) UV Initiated Dry Film Solder Masks
  TM 2.3.25 Detection of Ionizable Surface Contamination (Static Method)
  TM 2.3.26 Detection of Ionizable Surface Contamination (Dynamic Method)
  TM 2.3.26.1 Ionizable Detection of Surface Contaminants (Static Method)
  TM 2.3.31 Relative Degree of Cure in UV Curable Material
  TM 2.3.38 Inspection Test for Organic Contaminates on Printed Wiring Board and Assembly Surfaces
  TM 2.3.39 Identification of Residual Organic Non-Ionic Contaminates on Printed Wiring Boards and Assembly Surfaces
  TM 2.3.42 Identification of Solder Mask Products Using Fourier Transform Infrared Spectroscopy (FTIR)
  TM 2.4.27.2 Solder Mask Abrasion (Pencil Method)
  TM 2.4.28.1 Adhesion, Solder Mask (Over Melting and Non-Melting Metals)
  TM 2.4.29 Adhesion, Solder Mask—Flexible Circuits
  TM 2.5.6.1 Dielectric Strength, Polymer Solder Mask, and/or Conformal Coatings
  TM 2.6.1 Fungus Resistance, Printed Wiring Materials
  TM 2.6.3.1 Moisture and Insulation Resistance Polymeric Solder Masks and Conformal Coating
  TM 2.6.7.1 Thermal Shock—Polymer Solder Mask Coatings
  TM 2.6.11 Hydrolytic Stability—Solder Masks and Conformal Coatings
  TM 2.6.14 Resistance to Electrochemical Migration Solder Masks

IPC-CC-830 Qualification and Performance of Electrical Insulating Compound for Printed Board Assemblies
J-STD-003 Solderability Test Methods for Printed Wiring Boards
J-STD-004 General Requirements for Electronic Soldering Fluxes
J-STD-006 Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications

2.2 Underwriters’ Laboratories

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

2.3 ASTM

ASTM D2863 Oxygen index testing

3.0 REQUIREMENTS

3.1 Terms and Definitions The definition of terms shall be in accordance with IPC-T-50 and the following. In the event of conflict, the definitions specified herein shall take precedence.

3.1.1 Bleeding The flowing of a liquid solder mask coating beyond the areas of the image as applied.

3.1.2 Blisters Loss of adhesion typically caused by air or entrapped volatiles which appear under the mask during any high temperature thermal excursion.

3.1.3 Hydrolytic Stability The ability of an organic or polymeric material to withstand an irreversible change of state when exposed to an elevated temperature and humidity.
3.1.4 Skipping  When surface areas adjacent to or between conductors are not coated with a solder mask.

3.1.5 Solder Ball  A small sphere of solder adhering to a laminate, resist, or conductor surface (this generally occurs after wave solder or reflow soldering).

3.1.6 Webbing  Thin irregular pattern of solder adhering to the surface of a solder mask formed during the soldering operation.

3.1.7 Wrinkling  Ridges, creases, or furrows in solder mask covering a melting metal which form after melting and resolidification. The melting metal reaches its melting temperature and becomes molten under the solder mask coating during soldering causing the coating to appear uneven.

3.2 Conflict  In the event of conflict between the requirements of this specification and the requirements of the procurement document, the procurement document shall take precedence.

3.3 Qualification/Conformance  Three separate groups of testing (see 3.3.1-3.3.3) have been defined to provide assurance of material consistency and general qualification, as well as production process qualification and conformance. Although each group of testing is designed for use specifically by the solder mask vendor, printed board fabricator or designer, they may be conducted and/or modified by written agreement of all concerned parties. Qualification to a particular class as defined in 1.3 shall not be extended to cover any other class.

3.3.1 Solder Mask Material Property Evaluation and Conformance  Property evaluation and conformance is required to be performed by the solder mask vendor but may, by appropriate agreement, also be used as an incoming material inspection procedure by the printed board fabricator or user. The tests the solder mask vendor shall perform to determine the properties of each formulation/variation of solder mask material are listed in Table 1, Column A. Where applicable, test results are to be reported relative to properties defined in the physical requirements section of this standard.

3.3.2 Solder Mask/IPC-B-25A Test Board System Qualification  Test board system qualification provides a solder mask vendor with a method to specify the class to which his product(s) will qualify when tested with a standard board per tests listed in Table 1, Column B. Test results must report the laminate material (glass epoxy, polyimide, etc.) and conductor surface (copper, tin-lead, nickel/gold, etc.) which was used for this type of qualification, as well as designating class.

3.3.3 Solder Mask/Production Board Process Qualification Assessment  Production board process qualification assessment is the responsibility of the printed board fabricator and/or user to confirm. The production process chosen is qualified for the designated class and end use application. This testing utilizes test coupons evaluated according to tests listed in Table 1, Column C. By agreement of the printed board fabricator and user, substitute patterns on production board materials may be used to avoid the destruction of production boards.

Requalification by the fabricator shall be required when the solder mask, conductor surface (copper, nickel, gold, tin-lead, etc.), or substrate material (glass epoxy, polyimide, etc.) is changed from that used for the original qualification samples.

3.4 Materials  The solder mask and/or boards to be coated shall be free from deleterious substances and formulated or prepared to meet the designated requirements of this specification. Paragraphs 3.4.1 through 3.4.10 cover general characteristics for all solder mask materials.

3.4.1 Formulation Change  The following variations in the formulation of a solder mask material originally qualified by a supplier constitutes a material change and shall require a new name or product designation. The extent of the name change is up to the supplier, but the change in the name or designation must be prominently displayed and/or obvious to the user or end-user. Additionally, qualification of the changed solder mask formulation to this specification is expected. Qualification results of the original formula are not to be assumed for the new formula (See 6.5):

- Changes exceeding +/- 2% in the formula weight of any non-volatile ingredient from the ingredient’s original formula weight.
- Elimination of a non-volatile ingredient.
- Addition of a new non-volatile ingredient.
- Changes in type of dye or pigment.
- Any change in the mask that results in a change in the FTIR spectral response of the dried mask. (See IPC-TM-650, TM 2.3.42)
- Addition, deletion or change in composition of “inert” materials in the formulation such as matting agent(s).

The following do not constitute a change in formulation and do not require requalification:

- Changes of less than +/- 2% in the formula weight of any non-volatile ingredient from the ingredient’s original formula weight.
- Changes in volatile components (solvents) where the residual amount in the dried coating (under recommended drying conditions) is less than 1% of the dried weight.
Changes in the % solids vs. volatiles of the solder mask as supplied to user.

### 3.4.2 Compatibility
The solder mask materials shall be suitable for application and use on printed boards and shall be chemically, physically, environmentally, and electrically compatible with materials of construction. These materials shall not cause deterioration of materials used in printed board assemblies or components mounted/connected thereon. The material shall not corrode any metal being covered.

**Note:** Confirmation of compatibility of a solder mask material with any item or substance not specified herein is the responsibility of the party utilizing such item or substance.

### 3.4.3 Shelf Life
The solder mask coating shall be applied and cured within the shelf life specified by the solder mask vendor. Shelf life and storage requirements shall be specified by the solder mask vendor.

### 3.4.4 Color
The color(s) of the solder mask material shall be the standard color for the product type as qualified by the solder mask vendor. Clear, unpigmented masks are acceptable.

### 3.4.5 Cure
The cure of solder masks covered by this specification may be functionally determined by meeting the requirements of solvent and cleaning agent resistance (3.6.1.1), solderability (3.7.1), and solder resistance (3.7.2).

**Note:** Other test methods for monitoring level of cure or

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### Table 1 Requirements of Qualification/Conformance

<table>
<thead>
<tr>
<th>Requirement</th>
<th>SM-840 Paragraph</th>
<th>IPC Test Method</th>
<th>Vendor Testing Requirements</th>
<th>Fabricator Testing Requirements</th>
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<td>Column B</td>
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<td>2.6.1</td>
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<td>N/A</td>
<td>N/A</td>
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</tbody>
</table>

- **X** = Testing Required
- **N/A** = Not Applicable
- **N/R** = Not Required
- **U/O** = User Option
- ***** = Must be Specified
control of the curing process are sometimes used. For further information on several of these methods see paragraph 6.3.

3.4.6 Non-Nutrient  The cured solder mask shall not contribute to, support, or be degraded by biological growth when tested as specified in TM 2.6.1 of IPC-TM-650.

3.4.7 Design  Solder mask adhesion to melting metal surfaces (solder coating, tin/lead plating, etc.) can not be assured as boards are subjected to temperatures that cause redistribution of the melting metals. When solder mask is required over melting metal surfaces, in order to be able to meet the adhesion requirements of this document, the maximum recommended conductor width where the mask completely covers the conductor shall be 1.3 mm [0.050 inch].

When conductors of melting metal have a width larger than 1.3 mm [0.050 inch], the design of the conductor shall provide a relief through the metal to the base laminate substrate. The relief should be at least 6.45 mm² [0.010 square inches] in size and located on a grid no greater than 6.35 mm [0.250 inch].

When conductor areas of melting metal are to be left uncovered, the design for all class boards shall provide that the solder mask shall not overlap the melting metal. Solder mask-to-land relationship shall meet the registration requirements stated on the master drawing.

3.4.8 Visual Requirements  Solder mask appearance shall be observed visually in all stages of evaluation, qualification, and conformance inspection with the aid of a magnifying lens rated between 1.75 and 10X magnification unless otherwise specified.

The material shall be uniform in appearance and free of foreign materials, cracks, inclusions, peeling, and roughness that would interfere with the assembly or operation of the printed board. Discoloration of metallic surfaces under the cured solder mask shall be acceptable.

3.4.9 Touch-up  Touch-up of discontinuities shall be allowed provided that the end product meets all the requirements specified herein.

3.4.10 Dimensional Requirements  The cured solder mask shall visually cover all required surfaces. Solder mask applied shall withstand a minimum of 500 VDC when tested in accordance with TM 2.5.6.1 of IPC-TM-650 and shall prevent solder pick-up on circuitry during solder leveling and assembly soldering.

The board fabricator shall confirm that the minimum thickness on the board is sufficient to withstand 500 VDC per solder mask vendor’s specification. The coating thickness shall be measured by any micrometer or indicator accurate to 0.0025 mm [0.0001 inch] or microsection in accordance with TM 2.1.1 of IPC-TM-650.

If a specific thickness or breakdown voltage is required it shall be specified by the end user on the procurement document.

3.5 Physical Requirements

3.5.1 Pencil Hardness  When tested in accordance with TM 2.4.27.2 of IPC-TM-650, the cured solder mask shall not be scratched by a pencil which is softer than an “F” hardness.

3.5.2 Adhesion  The following paragraphs provide requirements for testing adhesion of solder mask to rigid or flexible substrates. Only those requirements necessary to evaluate material to a particular application need be imposed.

<table>
<thead>
<tr>
<th>Surface</th>
<th>Maximum Percentage Loss Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Copper</td>
<td>0</td>
</tr>
<tr>
<td>Gold or Nickel</td>
<td>5</td>
</tr>
<tr>
<td>Base Laminate</td>
<td>0</td>
</tr>
<tr>
<td>Melting Metals (Tin-Lead Plating, Fused Tin-Lead and Bright Acid Tin)</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2  Adhesion to Rigid Boards  (IPC-B-25A Board and/or Production Board)

Note: While it is recognized that solder mask has little adherence to tin/lead after it reflo w, the solder mask should have sufficient integrity to remain intact during tape testing to meet the requirements of Table 2. See paragraph 6.4.

3.5.2.1 Adhesion to Rigid Printed Wiring  The adhesion of the cured solder mask to melting (e.g. tin-lead or bright acid tin when exposed above its melting point) or to non-melting (e.g. copper, nickel, etc.) metals shall be determined in accordance with TM 2.4.28.1 of IPC-TM-650. The maximum percentage of cured solder mask lifted from the surface of the rigid base material or conductive material of the checker board pattern prior to and subsequent to exposure to solder per 3.7.1 shall be in accordance with Table 2.

Note: Use of alternate coupon patterns or production boards shall only be allowed when agreed upon between fabricator and user. (See paragraph 6.4 for performance requirements.)

3.5.2.2 Adhesion to Flexible Printed Wiring  The cured solder mask over flexible circuits shall not exhibit separation, fracturing, or delamination from the surface of the
base material, conductors and lands of the coated flexible printed wiring after 25 cycles when tested in accordance with TM 2.4.29 of IPC-TM-650, using a 3.175 mm [0.125 inch] diameter mandrel.

3.5.2.3 Via Protection When the design requires the protection (plugging, tenting, etc.) of vias, quality conformance test circuitry coupons shall each include a minimum of six (6) protected vias per coupon that are representative of the board design. Protected vias shall have no failures when using the same materials and technique defined in IPC test method 2.4.28.1.

3.5.2.4 Nomenclature Compatibility When nomenclature is to be applied in a subsequent operation, careful definition of adhesion requirements and the required test method(s) for that nomenclature to the production board system must be agreed upon by the printed board fabricator and his user customer.

3.5.2.5 Conformal Coating Adhesion When conformal coating is to be applied in a subsequent operation, careful definition of adhesion requirements and the required test method(s) for that conformal coating to the production board system must be agreed upon by the printed board fabricator and his user customer (see IPC-CC-830).

3.5.3 Machinability The cured solder mask applied over the base laminate shall not be cracked or torn more than that observed on the substrate used when subjected to drilling, routing, sawing or punching that is normally associated with the printed board manufacturing process when visually examined with 20/20 corrected vision without magnification.

3.6 Chemical Requirements

3.6.1 Resistance to Solvents, Cleaning Agents, and Fluxes The cured solder mask coating should be tested by the printed board fabricator and/or his user for resistance to those solvents, cleaning agents, fluxes, or other chemicals which are encountered in the intended manufacturing, repair, and maintenance processes and to the end use environment to which the production board system will or may be subjected, and are not specified herein.

3.6.1.1 Resistance to Solvents and Cleaning Agents The cured solder mask coating shall not exhibit a degradation in surface characteristics, such as surface roughness, swelling, tackiness, blistering, or color change, as shall be determined by exposing the specimens to the conditions listed in Table 3. Resistance to each agent shall be tested separately. New specimens shall be used for each agent. After immersion, specimens shall be hung to dry for ten minutes at ambient laboratory conditions, after which they are to be visually examined with 20/20 corrected vision without magnification for surface degradation such as roughness, blisters, delamination, cracking, swelling and color change.

Table 3 Resistance to Solvents and Cleaning Agents

<table>
<thead>
<tr>
<th>Solvent/Cleaning Agent</th>
<th>Temperature</th>
<th>Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isopropanol</td>
<td>Std laboratory, room</td>
<td>2</td>
</tr>
<tr>
<td>75% Isopropanol/25% Water</td>
<td>46 ±2°C</td>
<td>15</td>
</tr>
<tr>
<td>D-Limonene</td>
<td>Std laboratory, room</td>
<td>2</td>
</tr>
<tr>
<td>10% Alkaline detergent (for example, ≤40% alkanolamine, ≤20% 2-butoxyethanol, ≤20% glycol ether and the remaining 90% water; pH ≤13)</td>
<td>57 ±2°C</td>
<td>2</td>
</tr>
<tr>
<td>Monoethanolamine</td>
<td>57 ±2°C</td>
<td>2</td>
</tr>
<tr>
<td>Deionized water</td>
<td>60 ±2°C</td>
<td>5</td>
</tr>
</tbody>
</table>

3.6.1.2 Resistance to Assembly Process and Chemistry The resistance of the cured solder mask shall be determined using the appropriate flux and cleaner specified in the procurement document. After processing, examine the solder mask for surface degradation such as roughness, blisters, delamination, cracking, swelling and color change when visually examined with 20/20 corrected vision without magnification.

3.6.2 Hydrolytic Stability/Aging The cured solder mask shall be designated as being able to withstand 97 ±2°C, 90-98%RH for a duration of 28 days, without an irreversible change of state. Resistance to reversion shall be determined by examining the appearance and surface tackiness in accordance with TM 2.6.11 of IPC-TM-650.

3.6.3 Flammability The flammability performance of the cured solder mask shall be determined in accordance with UL 94.

3.6.3.1 Class H The solder mask coating material shall not raise the UL 94 flammability “V” number of the base laminate for Class H material.

3.6.3.2 Class T For Class T materials, the “V” number shall not be raised by more than one, and the rating shall be at least V-1. The oxygen index (determined per ASTM D2863) shall be ≥28 percent.

3.7 Soldering Requirements

3.7.1 Solderability The solder mask coating shall not adversely affect the solderability of the areas intended to be soldered when tested as specified in accordance with J-STD-003.
3.7.2 Resistance to Solder  Immediately after exposure to solder, inspect visually in accordance with paragraph 3.4.8 for the resistance of solder mask to accept solder. This is also an indication of acceptable cure.

The solder mask coating shall completely resist the adherence of solder when tested as follows:

Coat the specimens with a Type “M” flux per J-STD-004 (Column B) or the flux approved for production (Column C). Hold at ambient temperature for five minutes. Preheat (per the flux suppliers recommendation) and solder float (Sn 60 or Sn 63 solder per J-STD-006) at 260 ±5°C for 10 ±1 seconds.

3.8 Electrical Requirements

3.8.1 Dielectric Strength  When tested in accordance with TM 2.5.6.1 of IPC-TM-650, the solder mask material shall meet or exceed the minimum value of 500 VDC per 0.025 mm [0.001 inch] of thickness. Thickness of solder mask less than 0.025 mm [0.001 inch] shall meet an absolute minimum breakdown voltage of 500 volts DC.

3.8.2 Insulation Resistance  The solder mask coated sample shall have a minimum insulation resistance, in either standard or production board systems, before and after performing the resistance to solder test of 3.7.2. The insulation resistance of the production board system shall be determined in accordance with the initial ambient temperature insulation resistance measurement or TM 2.6.3.1 of IPC-TM-650.

A minimum insulation resistance of 500 megohms (5x10^8 ohms) shall be acceptable when measured on a comb or “Y” pattern with a minimum spacing greater than or equal to 0.125mm [0.005 inch].

3.9 Environmental Requirements

3.9.1 Moisture and Insulation Resistance  The solder mask coated board shall withstand the conditions listed in Table 4 without exhibiting blistering or separation. The moisture and insulation resistance (both at test conditions and stabilized to ambient conditions within 1 to 2 hours after removal from the chamber), shall be determined in accordance with TM 2.6.3.1 of IPC-TM-650.

3.9.2 Electrochemical Migration  The solder mask coated board shall not exhibit evidence of electrochemical migration when tested as specified in Table 5 and TM 2.6.14 of IPC-TM-650.

3.9.3 Thermal Shock  The solder mask coated board and/or the solder masked board conformally coated with a coating per IPC-CC-830 shall be required to pass all visual testing specified in 3.4.8 and shall not exhibit blistering, crazing or delamination when tested in accordance with TM 2.6.7.1 of IPC-TM-650 for the conditions shown in Table 6. When conformal coating is used, a crack in the solder mask is not sufficient reason for rejection unless the conformal coating is cracked. Prior to thermal shock testing specimens shall be exposed to solder per paragraph 3.7.1.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection  Unless otherwise specified, the solder mask vendor is responsible for the testing indicated in Columns A and B of Table 1 which shall constitute qualification testing of the solder mask material properties (3.3.1) and the solder mask process properties (3.3.2) in accordance with the requirements of paragraph 4.5. Quality conformance testing to insure continued performance of material properties shall be accomplished in accordance with 4.6.1.1.

Unless otherwise specified, the printed board fabricator and/or user is responsible for the testing indicated in Column C of Table 1. Qualification requirements for Column C are detailed in paragraph 4.5 and Table 10.

Test facilities utilized shall be agreed to by the appropriate parties affected and may be those of the solder mask vendor, printed board fabricator, user or other mutually acceptable site or combination thereof. The user reserves the right to confirm that any of the specified inspection procedures and test results conform to the prescribed paragraphs.

Note: When the printed wiring board is to be used in military electronic equipment, the prime contractor shall be responsible to insure that qualification and conformance testing are accomplished. Status/approval of testing facilities shall be in accordance with specific contractual requirements.

<table>
<thead>
<tr>
<th>CLASS</th>
<th>CONDITIONS Temp/RH</th>
<th>BIAS VOLTAGE (VDC)</th>
<th>TEST VOLTAGE (VDC)</th>
<th>DURATION</th>
<th>PATTERN</th>
<th>REQUIREMENT (megohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>65°C/90%</td>
<td>None</td>
<td>100.00</td>
<td>24 hr.</td>
<td>B-25A</td>
<td>500</td>
</tr>
<tr>
<td>H</td>
<td>25-65°C/85%</td>
<td>50</td>
<td>100</td>
<td>6 ⅔ days</td>
<td>B-25A or Y pattern</td>
<td>100, 500</td>
</tr>
</tbody>
</table>

Tolerance on all temperatures and humidities are as referenced in TM 2.6.3.1
4.1.1 Test Equipment and Inspection Facilities  Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit the performance of required inspection shall be established and maintained by or be acceptable to all concerned parties.

4.2 Categories of Inspection  The inspections specified are categorized as follows:

- Materials Inspection (see 4.3)
- Qualification Inspection (see 4.5)
- Quality Conformance Inspection (see 4.6)

A summary of criteria for qualification/conformance is shown in Table 7.

4.3 Materials Inspection  Materials inspection (defined in 3.3.1) shall consist of certification supported by verifying data based on statistical sampling that the materials used are in accordance with paragraph 3.4 (See Table 8).

4.4 Standard Laboratory Conditions  Test measurements and conditions, unless otherwise specified herein, or in the individual test specification, all shall be made at temperatures of 15 to 35°C at air pressure of 650 to 800 millimeters of mercury [0.86 to 1.05 bar], and a maximum relative humidity of 75 percent. Whenever these conditions must be closely controlled in order to obtain reproducible results for referee purposes, temperature, relative humidity and atmospheric pressure conditions of 25 +2/−5°C, 40-50 percent RH, and 650 to 800 millimeters of mercury [0.86 to 1.05 bar], shall be specified.

4.4.1 Permissible Temperature Variation in Environmental Chambers  When chambers are used, specimens under test shall be located only within the working area defined as follows:

a. Reference temperature variation within working area:

The controls for the chambers shall be capable of maintaining the temperature of any single reference point within the working area within ±2°C.

b. Spatial temperature variation within working area: Chambers shall be so constructed that, at any given time, the temperature of any point within the working area shall not deviate more than 3°C from the reference point, except for the immediate vicinity of specimens generating heat.

4.4.2 Reference Conditions  Reference conditions as a base for calculations shall be 25°C for temperature, or an alternate temperature of 20°C, 760 millimeters of mercury of air pressure, and a relative humidity of 50%.

4.5 Qualification Inspection  Qualification inspection may be performed at any of one or more locations under standard and/or production board system conditions (defined in 3.3.2 and 3.3.3). Because samples, equipment, procedures, systems and requirements may vary between locations, complete and precise reporting of the test details and verifying data is required. (see Tables 9 and 10).

4.5.1 Sample Size  The test specimens as defined by the method of examination shall be as specified in Tables 9 and 10.

4.5.2 Inspection Routine  The sample specimens shall be subjected to the inspections specified in the appropriate Column of Table 1 or a modification thereof agreed to by all concerned parties. A suggested sample utilization format is shown in Tables 9 and 10.

4.5.3 Failures  One or more failures shall be cause for retesting, preferably after the mode of failure has been determined and corrected.

4.6 Quality Conformance Inspection  Quality conformance testing of solder mask material and system properties and production boards shall be accomplished through testing of attributes as described in Table 9 or by statistical process control of key process parameters that are historically correlated to solder mask performance requirements.

4.6.1 Inspection of Product for Delivery  All inspection related items are referred back to IPC-RB-276, or by material and process control documentation of key process.

<p>| TABLE 5  Electrochemical Migration |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>CLASS</th>
<th>CONDITIONS (Temp/RH (°C/%))</th>
<th>BIAS VOLTAGE (VDC)</th>
<th>TEST VOLTAGE (VDC)</th>
<th>DURATION (hours)</th>
<th>PATTERN</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>85°C/85%</td>
<td>10.00</td>
<td>45-100</td>
<td>500</td>
<td>B-25A</td>
<td>&lt;1 decade drop in resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B-25 B</td>
<td>or E</td>
</tr>
<tr>
<td>H</td>
<td>85°C/90%</td>
<td>10.00</td>
<td>10.00</td>
<td>168</td>
<td>B-25 B</td>
<td>Resistance ≥2 megohms</td>
</tr>
</tbody>
</table>

Tolerance on all temperatures ±2°C and RH is ±3%.

<p>| TABLE 6  Thermal Shock Conditions |
|-------------------------------|-------------------------------|</p>
<table>
<thead>
<tr>
<th>CLASS</th>
<th>TEMPERATURE</th>
<th>NUMBER OF CYCLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>−65 to +125°C</td>
<td>100</td>
</tr>
<tr>
<td>(only when specified)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>−65 to +125°C</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 7 Summary of Criteria for Qualification/Conformance

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Paragraph</th>
<th>Test Method</th>
<th>D* or N</th>
<th>Class T</th>
<th>Class H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>3.4.8</td>
<td>N/A</td>
<td>N</td>
<td>Per details of Paragraph 3.4.8</td>
<td></td>
</tr>
<tr>
<td>Cure</td>
<td>3.4.5</td>
<td>N/A</td>
<td>N</td>
<td>Meet requirements of 3.6.1, 3.7.1, &amp; 3.7.2</td>
<td></td>
</tr>
<tr>
<td>Non-Nutrient</td>
<td>3.4.6</td>
<td>2.6.1</td>
<td>N</td>
<td>No support of, contribution to or degradation by biological growth</td>
<td></td>
</tr>
<tr>
<td>Dimensional</td>
<td>3.4.10</td>
<td>2.1.1</td>
<td>N</td>
<td>Defined by user &amp; 3.4.10; ≥500 VDC breakdown</td>
<td></td>
</tr>
<tr>
<td>Pencil Hardness</td>
<td>3.5.1</td>
<td>2.4.27.2</td>
<td>N</td>
<td>No damage by pencil softer than &quot;F&quot; hardness</td>
<td></td>
</tr>
<tr>
<td>Adhesion (tape)</td>
<td>3.5.2.1</td>
<td>2.4.28.1</td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bare Copper</td>
<td></td>
<td></td>
<td>N</td>
<td>Max 0% removed</td>
<td></td>
</tr>
<tr>
<td>Gold or Nickel</td>
<td></td>
<td></td>
<td>N</td>
<td>Max 5% removed</td>
<td></td>
</tr>
<tr>
<td>Base Laminate</td>
<td></td>
<td></td>
<td>N</td>
<td>Max 0% removed</td>
<td></td>
</tr>
<tr>
<td>Melting Metal</td>
<td></td>
<td></td>
<td>N</td>
<td>Max 10% removed</td>
<td></td>
</tr>
<tr>
<td>Flex Adhesion</td>
<td>3.5.2.2</td>
<td>2.4.29</td>
<td>N</td>
<td>No fracturing, separation or delamination</td>
<td></td>
</tr>
<tr>
<td>Machinability</td>
<td>3.5.3</td>
<td>N/A</td>
<td>N</td>
<td>No cracks or tears due to normal machining</td>
<td></td>
</tr>
<tr>
<td>Resistance to Solvents and Cleaning Agents</td>
<td>3.6.1 &amp; 3.6.1.1</td>
<td>N/A</td>
<td>N</td>
<td>No surface roughness, swelling, tackiness blistering or color change</td>
<td></td>
</tr>
<tr>
<td>Resistance to Assembly Process and Chemistry</td>
<td>3.6.1.2</td>
<td>N/A</td>
<td>N</td>
<td>Defined by User</td>
<td></td>
</tr>
<tr>
<td>Hydrolytic Stability/Aging</td>
<td>3.6.2</td>
<td>2.6.11</td>
<td>N</td>
<td>No irreversible change of state</td>
<td></td>
</tr>
<tr>
<td>Flammability - UL 94</td>
<td>3.6.3</td>
<td>UL 94</td>
<td>D</td>
<td>V Number shall not be raised more than 1. V-1 minimum</td>
<td></td>
</tr>
<tr>
<td>Solderability</td>
<td>3.7.1</td>
<td>N/A</td>
<td>N</td>
<td>Solderability of board shall not be diminished</td>
<td></td>
</tr>
<tr>
<td>Resistance to Solder</td>
<td>3.7.2</td>
<td>N/A</td>
<td>N</td>
<td>Solder shall not stick to the solder mask, no blistering</td>
<td></td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td>3.8.1</td>
<td>2.5.6.1</td>
<td>N</td>
<td>500VDC/0.001”; minimum 500 VDC if &lt;0.001”</td>
<td></td>
</tr>
<tr>
<td>Insulation Resistance (comb pattern)</td>
<td>3.8.2</td>
<td>2.6.3.1</td>
<td>N</td>
<td>≥500 meohms</td>
<td></td>
</tr>
<tr>
<td>Insulation Resistance (“Y” pattern after recovery)</td>
<td>3.8.2</td>
<td>2.6.3.1</td>
<td>N</td>
<td>≥500 meohms</td>
<td></td>
</tr>
<tr>
<td>Moisture and Insulation Resistance (comb pattern)</td>
<td>3.9.1</td>
<td>2.6.3.1</td>
<td>D</td>
<td>≥500 meohms (B-25A or B-25)</td>
<td></td>
</tr>
<tr>
<td>Moisture and Insulation Resistance (“Y” pattern after recovery)</td>
<td>3.9.1</td>
<td>2.6.3.1</td>
<td>D</td>
<td>≥100 meohms (B-25A) ≥500 meohms (B-25)</td>
<td></td>
</tr>
<tr>
<td>Electrochemical Migration</td>
<td>3.9.2</td>
<td>2.6.14</td>
<td>D</td>
<td>None allowed visually &lt;1 decade drop in resistance</td>
<td></td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>3.9.3</td>
<td>2.6.7.1</td>
<td>D</td>
<td>None allowed visually &gt;2 meohm resistance</td>
<td></td>
</tr>
<tr>
<td>Nomenclature Compatibility</td>
<td>3.5.2.4</td>
<td>N/A</td>
<td>N</td>
<td>Defined by User</td>
<td></td>
</tr>
<tr>
<td>Conformal Coating Adhesion/Compatibility</td>
<td>3.5.2.5</td>
<td>N/A</td>
<td>N</td>
<td>Defined by User</td>
<td></td>
</tr>
</tbody>
</table>

D = Differentiation of Classes
N = No Differentiation of Classes
4.6.1.1 Inspection of Solder Mask Properties  After initial testing to verify solder mask material properties in accordance with paragraph 3.3.1, batches of solder mask material shall be tested for compliance to the original requirements at a frequency to assure continuing performance. A batch or lot, as far as practical, shall consist of all coating materials, as applicable, provided by one continuous run or a combination of two or more continuous production runs offered for inspection at one time. Lot/batch identification is required (see paragraph 5.0).

This testing may consist of IPC-SM-840 qualification testing or by material and process control documentation per 4.6.1.

4.7 Preparation of Specimens for Test

4.7.1 Preparation Prior to Coating  Unless otherwise specified, the specimens shall be made with or without plated-through holes, in accordance with the detailed requirements of:

1) The IPC Multipurpose Test Board, Number IPC-B-25A (see Figure 1), or
2) Standard “Y” Patterns (see Figure 2);

Prior to coating, the board shall be properly cleaned. Cleanliness may be evaluated in accordance with TM 2.3.25, TM 2.3.26, TM 2.3.26.1, TM 2.3.38, or TM 2.3.39 of IPC-TM-650.

4.7.2 Coating  Unless otherwise specified, the solder mask coating pattern shall be in accordance with the detailed requirements of the IPC Multipurpose Test Board Solder Mask Pattern (see Figure 1) or the Standard “Y” Solder Mask Pattern (see Figure 2) as appropriate. The coating shall be applied to the appropriate system specimen and cured in a manner consistent with solder mask material vendor’s recommendations.

4.7.3 Number  The number of specimens required shall be of sufficient quantity to achieve statistical confidence and shall be, as a minimum, the three test specimens recommended for each test as specified in Tables 8, 9 & 10.

5.0 PREPARATION OF SOLDER MASK MATERIAL FOR DELIVERY

Unless otherwise specified, preservation, packaging and packing shall be in accordance with manufacturer practices and be labeled with solder mask description, manufacturer’s number and lot/batch control number and manufacturing date or expiration date.

6.0 Notes  The use of the information in the “Notes”
6.1 Specifying Solder Mask on Printed Wiring Boards

Documents/drawings should specify the following for solder mask on printed wiring boards where appropriate:

(a) Title, number and revision of this specification.
(b) Primary class of coating required (see 1.3).
   - Individual class requirements with deviations/exceptions/modifications which may be required/allowed from the general class specified.
(c) Special compatibility considerations (see 3.4.2 and 3.6.1.2).
(d) Special requirements (see 6.2). Customized tests/specimens, etc.

6.2 Special Requirements

For optimum utilization, this specification allows for the incorporation of requirements that specifically relate to the end product and its application. For this reason, the user is urged to utilize this specification as a basis to construct a customized procurement document in conjunction with his supplier and to consider the inclusion of special requirements in the procurement documents, especially in the following areas:

(a) Coating thickness (see 3.4.10).
(b) Custom test specimen (see 4.7.1 and 6.2(e)).
(c) Machinability (see 3.5.3).
(d) Solvents and fluxes (see 3.6.1).
(e) Printed board assembly and operational requirements (see 3.4.2 and 3.4.5).
(f) Conformal coating (see 3.5.2.5).
(g) Deviations or additional requirements to the standard.
(h) Flexible circuitry

6.3 Assorted Methods for Monitoring or Controlling Cure of Solder Mask

A number of methods exist which have been used to monitor or determine the acceptability of the curing process and/or the finished product. These methods (copies of which are included in the test method section) are listed below with considerations of their value:

<table>
<thead>
<tr>
<th>Method</th>
<th>Required?</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>IPC-TM-2.3.23</td>
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</tbody>
</table>

Cure (Permanency) Thermally Cured Solder Masks

This method has been used for quite some time to confirm the acceptability of the curing process and/or the finished product. These methods (copies of which are included in the test method section) are listed below with considerations of their value:

<table>
<thead>
<tr>
<th>Method</th>
<th>Required?</th>
<th>Value</th>
</tr>
</thead>
<tbody>
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<td>IPC-TM-2.3.31</td>
<td></td>
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</tbody>
</table>

6 January 1996 IPC-SM-840C
Relative Degree of Cure in UV Curable Materials

This method is useful in setting up and establishing control of the curing process for UV screen defined solder mask. It is not considered to be an appropriate method of determining that the proper level of solder mask cure has been achieved on actual production boards. Reasons for this include:

1) The test is a measurement of depth of cure not degree of cure.
2) The substrate defined in the test is a milled stainless steel block, is highly reflective and therefore allows a more complete cure than a board would see.
3) The thickness of the solder mask on a real circuit board is not always consistent, creating the potential for undercure.

IPC-TM-2.3.23.1

Cure (Permanency) UV Initiated Dry Film Solder Masks

This method is a nondestructive test which can be run relatively quickly. It does, however, require the use of radioactive tracer materials which are in quickly evaporating solvents. Also, experience has shown that each type of solder mask requires a different solvent for optimum reliability. It also requires knowing exactly which cure process was used to permit proper interpretation of the results. This method may have value as a process control tool, but the value as a general method for determining degree of cure is extremely limited.

6.4 Solder Mask Adhesion

If a solder mask passes before soldering, and fails after soldering, the entire board system (board design, cleanliness, solder mask application, and solder mask) must be examined to determine the failure mechanism.

Figure 1 IPC-B-25A (Note: No solder mask is applied to contact fingers)

Figure 2 Test Coupon (“Y” Configuration)
Circuit height, solder mass, soldering parameters, circuit density, fluxes, cleaning solutions, etc. can individually or collectively affect the solder mask adhesion.

The checkerboard pattern (test method 2.4.28.1) has been required by this document for adhesion testing, as it represents the limits of recommended solder mask design (paragraph 3.4.7) and provides an equal number of metal and open laminate squares to facilitate percentage-loss evaluation. In the absence of the checkerboard pattern, the board fabricator/user shall agree upon the appropriate location on a production board for determination of adhesion. This location must contain a representative configuration of conductors and bare laminate (ground planes and conductors over 1.25 mm (0.050") not recommended). A determination shall be made computing the total conductor surface area to which the tape is attached, followed by evaluation of the surface area of the solder mask adhering to the tape after testing. The percentage loss over the conductor shall be calculated by the following formula:

Percent Loss = \[(\text{Surface area of solder mask removed from conductor/Surface area of the conductor tested}) \times 100\].

A similar calculation can be made for the base laminate. The requirements are defined in Table 2.

While it is recognized that solder mask has little adherence to tin/lead after it reflows, the solder mask should have sufficient integrity to remain intact during tape testing to meet the requirements of Table 2.

6.5 Formulation Change  It is important when using materials such as solder mask that the properties of the material remain consistent throughout the life of the product. Small changes in the composition of the product may have dramatic effects upon some properties (such as flammability, adhesion etc.) and how the product behaves in application and in assembly. Compatibility of solder mask with associated materials (such as fluxes, cleaning agents, nomenclatures, conformal coatings, etc.) can often be a sensitive issue. Therefore, it is important to maintain consistent product formulation and to signal users when a change has been made. Definition of what is actually a “change” (resulting in a “new” product) is difficult because each component in a formulation has a different effect upon performance. See paragraph. 3.4.1 for definition of a formulation change.

6.6 Ionics  Solvent extract conductivity measurements have become commonplace in this industry. A number of equipment manufacturers have built testing equipment that can give a measurement of the amount of extractable ionic material left on a PWB after it has been through a particular process. These typically utilize a mixture of isopropyl alcohol and water to perform the extraction.

The Ionic Conductivity Task Group, based upon testing conducted at the “Electronics Manufacturing Production Facility” (Report #RR0013 - “An In-Depth Look at Ionic Cleanliness Testing” - August 1993) has made an extensive study of this topic. In this report it was concluded that this measurement is only suitable for use as a process control tool, and not for an absolute measurement or limit to be maintained for all processes, materials or test equipment.

Some of the General Observations from this report are:

- “Ionic conductivity testing should not be the sole method for evaluating and choosing a process or material. Other methods include ion chromatography, HPLC, surface insulation resistance (SIR), electrochemical migration and residual rosin analysis.

Close variable control is required on current ionic conductivity test methods and equipment to maintain consistency. Current ionic conductivity test methods and equipment can be validly used for process control tools. Though there are variables that influence final ionic readings, all of the systems will detect equipment failures, material handling and process errors. Current ionic cleanliness systems will indicate subtle changes to a users existing manufacturing process, when used as a process control tool.

While they are suitable for use in process control, current ionic conductivity/resistivity test methods and equipment are not accurate analytical tools and should be used for monitoring relative changes in cleanliness. This is consistent with the development and use of test methods since 1972.

Pass/fail limits and equivalency factors are not valid applications for current ionic conductivity/resistivity test methods and equipment due to the accuracy and precision problems noted above.”

Some of the reasons supporting this conclusion deal with the fact that this test gives significantly different results depending upon the following variables:

- Flux composition – The materials used in different fluxes have different affinity to different masks and then have different solubility rates in the IPA/water extraction. Consequently, making one recommendation for all materials and conditions is not practical.

- Test Equipment – Equipment from different manufacturers will give different results due to engineering (static/dynamic; heated/unheated; spray/no spray; etc.) and process differences.

- Test Method – There are process effects from how the test is controlled and performed.

- Alcohol Concentration – lower alcohol concentrations yield higher levels of detected ionic contamination

- Test Temperature – Some test equipment heats the test solution. Test equipment with heated solutions will typically give an ionics reading much higher than those
operating at room temperature. At 115°F the measurement has been noted to be 1.5X to 3X the room temperature reading. Even systems designed to operate at “room temperature” may experience test solution temperature differences over a day’s time sufficient to give variable results.

— Other Variables — There are variations created in results from initial solution cleanliness levels (“deadband”), carbon dioxide absorption and volume effects in the test. Due to the above, it is not practical to make a single specification for ionic cleanliness. The test method and limits must be agreed upon between each individual supplier and user.

6.7 Hole Plugging – Via Protection  The need for protection of vias has evolved from a convenience to the point where it is now a necessity to make current board designs manufacturable at reasonable yield and cost. Numerous techniques are possible, yet all have the same objective - to prevent assembly materials (solder and/or chemistry) from propagating from one side of the PWB to the other. Common problems/needs treated through via protection are:

- Vacuum hold down of boards for electrical testing
- Wave soldering flux under SMDs on the top of the board
- Solder Bridging under SMDs on the top of the board
- Incomplete filling of vias during wave soldering
- Need for electrical insulation of the via annular ring
- Provide a proper surface for plating circuitry
- Eliminate wicking of solder into vias during reflow soldering

Via protection may be accomplished in a number of different ways including:

Before Solder Masking – Holes are plugged with the same or different material - plug typically adheres to copper circuitry

During Solder Masking – with dry film or capped liquid - solder mask material is polymerized in/over the via. Hole is either “tented” or filled with the solder mask material typically adhered to copper circuitry.

After Solder Masking/Before Solder Leveling – Holes are plugged with the same or different material - plug adheres to the solder mask and the copper in the hole.

After Masking and Solder Leveling – Holes are plugged with the same or different material - plug adheres to the solder mask and to the solder in the hole.

Single- or Double-sided – It is common to want to use one side of a via for electrical testing. This requires that the annular ring of the via on one side not be coated with solder mask or the hole plugging material.

Some considerations when selecting a via protection method:

Planarity

In assembly it is typically important to have a relatively planar surface to the PWB as it is received. In many cases components will be placed directly over protected vias and, if there is any bulge or bump at the via, the component will not sit firmly onto its mounting pad(s) creating the potential for a soldering defect(s).

It is also very important to maintain this planarity through assembly soldering. Bulged, erupted or popped vias can dislocate components and cause soldering defects as above.

Via Metallization

When vias are solder coated before they are coated with a material the plug of material in the hole can become loose as the solder refloows or melts during soldering processes. This can lead to either plug failure or a soldering defect. However, if this type of plug does fail, the copper of the hole wall is protected from chemical attack by the solder coating. Even though this practice may be more prone to failure, the consequences, in terms of long-term reliability, may not be as much of a concern.

Bare copper protected vias are more likely to survive assembly processing because the plugging material can maintain excellent adhesion to the copper surface, just the same as to circuitry (assuming that an approved solder mask material is used). However, if a failure did occur, there could be a long-term reliability concern in that it could expose bare copper to chemistry and the environment. If the circuitry was gold plated, however, there would essentially be no concern from failed via protection because of the inertness of the gold.

Moisture Absorption

Because materials used to plug vias can absorb moisture during storage, it may be necessary to bake boards with protected vias before soldering to eliminate absorbed moisture from the holes. This should increase the reliability of the via protection through the soldering process.
Standard Improvement Form

The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:
IPC
2215 Sanders Road
Northbrook, IL 60062-6135
Fax 847 509.9798

1. I recommend changes to the following:
   ___ Requirement, paragraph number _________
   ___ Test Method number _________, paragraph number _________

   The referenced paragraph number has proven to be:
   ___ Unclear   ___ Too Rigid    ___ In Error
   ___ Other

2. Recommendations for correction:

   ___________________________________________________
   ___________________________________________________
   ___________________________________________________
   ___________________________________________________
   ___________________________________________________

3. Other suggestions for document improvement:

   ___________________________________________________
   ___________________________________________________
   ___________________________________________________
   ___________________________________________________
   ___________________________________________________

Submitted by:

Name

Company

Address

City/State/Zip

Telephone

Date
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The IPC staff will research your technical question and attempt to find an appropriate specification interpretation or technical response. Please send your technical query to the technical department via:

tel 847/509-9700  fax 847/509-9798
http://www.ipc.org  e-mail: answers@ipc.org

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  ComplianceNet forum covers environmental, safety and related regulations or issues.

- **DesignerCouncil@ipc.org**
  Designer Council forum covers information on upcoming IPC Designers Council activities as well as information, comment, and feedback on current design issues, local chapter meetings, new chapters forming, and other design topics.

- **Roadmap@ipc.org**
  The IPC Roadmap forum is the communication vehicle used by members of the Technical Working Groups (TWGs) who develop the IPC National Technology Roadmap for Electronic Interconnections.

- **IPCs840@ipc.org**
  This peer networking forum is specific to solder mask qualification and use.

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Subject: 
Message: subscribe TechNet Joseph H. Smith

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Message: <your message>

The associated e-mail message text will be distributed to everyone on the list, including the sender. Further information on how to access previous messages sent to the forums will be provided upon subscribing.

For more information, contact Dmitriy Sklyar
tel 847/509-9700 x311  fax 847/509-9798
e-mail: sklydm@ipc.org  http://www.ipc.org/html/forum.htm
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Our home page provides access to information about upcoming events, publications and videos, membership, and industry activities and services. Visit soon and often.

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IPC conducts local educational workshops and national conferences to help you better understand emerging technologies. National conferences have covered Ball Grid Array and Flip Chip/Chip Scale Packaging. Some workshop topics include:

- Printed Wiring Board Fundamentals
- Troubleshooting the PWB Manufacturing Process
- Choosing the Right Base Material Laminate
- Design for Manufacturability
- Acceptability of Printed Boards
- Design for Assembly
- New Design Standards
- High Speed Design
- Designers Certification Preparation

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e-mail: markp@taos.newmex.com
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IPC-A-610 Training and Certification Program
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tel 847/509-9700 ext. 308  fax 847/509-9798
e-mail: rilejo@ipc.org  http://www.ipc.org/html/610.htm

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tel 847/509-9700 ext. 319  fax 847/509-9798
e-mail: behrki@ipc.org  http://www.ipc.org

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The first step is to join IPC. An application for membership can be found on page 74. Once you become a member, the opportunities to enhance your competitiveness are vast. Join a technical committee and learn from our industry's best while you help develop the standards for our industry. Participate in market research programs which forecast the future of our industry. Participate in Capitol Hill Day and lobby your Congressmen and Senators for better industry support. Pick from a wide variety of educational opportunities: workshops, tutorials, and conferences. More up-to-date details on IPC opportunities can be found on our web page: http://www.ipc.org.

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Jeanette Ferdman, Membership Manager
tel 847/509-9700 ext. 309  fax 847/509-9798
e-mail: JeanetteFerdman@ipc.org  http://www.ipc.org
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Thank you for your decision to join IPC members on the “Intelligent Path to Competitiveness”! IPC Membership is site specific, which means that IPC member benefits are available to all individuals employed at the site designated on the other side of this application.

To help IPC serve your member site in the most efficient manner possible, please tell us what your facility does by choosing the most appropriate member category.

Our facility manufactures and sells to other companies, printed wiring boards or other electronic interconnection products on the merchant market.

**WHAT PRODUCTS DO YOU MAKE FOR SALE?**

- [ ] One-sided and two-sided rigid printed boards
- [ ] Multilayer printed boards
- [ ] Flexible printed boards
- [ ] Flat cable
- [ ] Hybrid circuits
- [ ] Discrete wiring devices
- [ ] Other interconnections

Name of Chief Executive Officer/President________________________

Our facility assembles printed wiring boards on a contract basis and/or offers other electronic interconnection products for sale.

- [ ] Turnkey
- [ ] Through-hole
- [ ] Mixed Technology
- [ ] Consignment
- [ ] BGA
- [ ] Chip Scale Technology

Name of Chief Executive Officer/President________________________

Our facility purchases, uses and/or manufactures printed wiring boards or other electronic interconnection products for our own use in a final product. Also known as original equipment manufacturers (OEM).

**IS YOUR INTEREST IN:**

- [ ] purchasing/manufacture of printed circuit boards
- [ ] purchasing/manufacturing printed circuit assemblies

What is your company’s main product line?_____________________________________

Our facility purchases, uses and/or manufactures printed wiring boards or other electronic interconnection products for our own use in a final product. Also known as original equipment manufacturers (OEM).

**IS YOUR INTEREST IN:**

- [ ] purchasing/manufacture of printed circuit boards
- [ ] purchasing/manufacturing printed circuit assemblies

What is your company’s main product line?_____________________________________

Our facility supplies raw materials, machinery, equipment or services used in the manufacture or assembly of electronic interconnection products.

**WHAT PRODUCTS DO YOU SUPPLY?**

We are representatives of a government agency, university, college, technical institute who are directly concerned with design, research, and utilization of electronic interconnection devices. (Must be a non-profit or not-for-profit organization.)

Please be sure both sides of this application are correctly completed
# Application for Site Membership

## Site Information:

<table>
<thead>
<tr>
<th>Company Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Address</td>
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<td>Mail Stop</td>
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</table>

## Please check one:

- $1,000.00  Annual dues for Primary Site Membership (Twelve months of IPC membership begins from the time the application and payment are received)
- $800.00  Annual dues for Additional Facility Membership: Additional membership for a site within an organization where another site is considered to be the primary IPC member.
- $600.00**  Annual dues for an independent PCB/PWA fabricator or independent EMSI provider with annual sales of less than $1,000,000.00. **Please provide proof of annual sales.
- $250.00  Annual dues for Government Agency/University/not-for-profit organization

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## AMRC Membership

- Please send me information for Membership in the Assembly Marketing Research Council (AMRC)

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Authorized Signature ____________________

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Chicago, IL 60678-3491

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PLEASE ATTACH BUSINESS CARD OF OFFICIAL REPRESENTATIVE HERE
IPC-SM-840C

Qualification and Performance of Permanent Solder Mask

Amendment 1
The Principles of Standardization

In May 1995 the IPC’s Technical Activities Executive Committee 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

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IPC Position Statement on Specification Revision Change

It is the position of IPC’s Technical Activities Executive Committee (TAEC) 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 standard/guideline 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 lastest revision.

Adopted October 6, 1998

Why is there a charge for this standard?

Your purchase of this document contributes to the ongoing development of new and updated industry standards. 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 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.

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Thank you for your continued support.
Qualification and Performance of Permanent Solder Mask

1.2 Purpose

Paragraph 1:
Replace:
IPC-RB-276
With:
IPC-6011 and IPC-6012

Add the following paragraph at the end of section:

13.2.1 General “R13-11 [813] In lieu of the requirements in this section for solder mask, testing to IPC-SM-840C, January 1996, Class “T” requirements shall be acceptable. The requirements contained in the IPC document are similar or equivalent to the ones contained herein.”

1.3 Classes

Add the following paragraph at the end of section:
Note: Solder mask types were previously described as Type A for screen imaged (liquid) or coverlay for flex (dry), and Type B for all types of photo defined solder mask (liquid or dry film).

3.4.1 Formulation Change

4th bullet point
Replace:
• Changes in type of dye or pigment.
With:
• Changes in type of dye or pigment, excluding coloring dye or pigment within a defined, tested range of lowest (none) and highest (supplied) loading levels of the specific coloring materials.

6th bullet point
Replace:
• Addition, deletion or change in composition of “inert” materials in the formulation such as matting agent(s).
With
• Addition, deletion or change in composition of “inert” materials in the formulation such as matting agent(s), excluding a change in quantity of a single “inert” material already present in the formula within a defined, tested range of lowest (none) and highest (supplied) loading levels of that specific “inert” material. Change to more than one material is considered a formulation change.

2.1 IPC

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<thead>
<tr>
<th>Replace the following:</th>
<th>With the following:</th>
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<tbody>
<tr>
<td>IPC-RB-276 Qualification and Performance of Rigid Printed Boards</td>
<td>IPC-6011 Generic Performance Specification for Printed Boards</td>
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<tr>
<td>IPC-6012 Qualification and Performance specification for Rigid Printed Boards</td>
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<tr>
<td>TM 2.3.25 Detection of Ionizable Surface Contamination (Static Method)</td>
<td>TM 2.3.25 Detection and Measurement of Ionizable Surface Contaminants</td>
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<tr>
<td>TM 2.3.26 Detection of Ionizable Surface Contamination (Dynamic Method)</td>
<td>TM 2.3.26.1 Ionic Cleanliness Testing of Bare Printed Wiring Boards</td>
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<td>TM 2.3.26.1 Ionizable Detection of Surface Contamination (Static Method)</td>
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<td>TM 2.3.38 Inspection Test for Organic Contaminates on Printed Wiring Board and Assembly Surfaces</td>
<td>TM 2.3.38 Surface Organic Contaminant Detection Test</td>
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<td>TM 2.3.39 Identification of Residual Organic Non-Ionic Contaminates on Printed Wiring Boards and Assembly Surfaces</td>
<td>TM 2.3.39 Surface Organic Contaminant Identification Test (Infrared Analytical Method)</td>
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<td>TM 2.4.28.1 Adhesion, Solder Mask (Over Melting and Non-Melting Metals)</td>
<td>TM 2.4.28.1 Adhesion, Solder Resist (Mask), Tape Test Method</td>
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<td>TM 2.6.3.1 Moisture and Insulation Resistance Polymeric Solder Masks and Conformal Coating</td>
<td>TM 2.6.3.1 Moisture and Insulation Resistance – Solder Masks</td>
</tr>
<tr>
<td>TM 2.6.7.1 Thermal Shock – Polymer Solder Mask Coatings</td>
<td>TM 2.6.7.3 Thermal Shock – Solder Mask</td>
</tr>
<tr>
<td>TM 2.6.11 Hydrolytic Stability – Solder Masks and Conformal Coating</td>
<td>TM 2.6.11 Hydrolytic Stability – Solder Mask</td>
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</tbody>
</table>

3.4.5 Cure

*Add sentence at the end of Note:*

Contact manufacturer of solder mask to determine method to test cure.

3.4.10 Dimensional Requirements

*Replace:*

If a specific thickness or breakdown voltage is required it shall be specified by the end user on the procurement document.

*With:*

If a specific thickness or breakdown voltage is required or allowed it shall be specified by the end user on the procurement document.

Table 1 Thermal Shock IPC Test Method

*Replace:*

2.6.7.1

*With:*

2.6.7.3

Table 4

*Delete and replace with:*

<table>
<thead>
<tr>
<th>Class</th>
<th>Test Temperature</th>
<th>Test Humidity</th>
<th>Bias Voltage (VDC)</th>
<th>Test Voltage (VDC)</th>
<th>Duration</th>
<th>Test Pattern IPC-B-25A Board</th>
<th>Requirements (megohm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>65°C ± 2°C</td>
<td>90 ± 3 %</td>
<td>0</td>
<td>100</td>
<td>24 hours</td>
<td>E and F, C</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>[149°F ± 3.6°F]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>25°C to 65°C ± 2°C</td>
<td>90, -5, + 3%</td>
<td>50</td>
<td>100</td>
<td>6 2/3 days</td>
<td>D, C</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>[77°F to 149°F ± 3.6°F]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5

*Delete and replace with:*

<table>
<thead>
<tr>
<th>Class</th>
<th>Test Temperature</th>
<th>Test Humidity</th>
<th>Bias Voltage (VDC)</th>
<th>Test Voltage (VDC)</th>
<th>Duration</th>
<th>Test Pattern IPC-B-25A Board</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>85°C ± 2°C</td>
<td>85% minimum</td>
<td>10</td>
<td>45 - 100</td>
<td>500 hours</td>
<td>D, C</td>
<td>&lt; 1 decade drop in resistance</td>
</tr>
<tr>
<td></td>
<td>[185°F ± 3.6°F]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>85°C ± 2°C</td>
<td>90%</td>
<td>10</td>
<td>10</td>
<td>168 hours</td>
<td>D, C</td>
<td>Resistance ≥ 2 megohms</td>
</tr>
<tr>
<td></td>
<td>[185°F ± 3.6°F]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.9.3 Thermal Shock

*Replace:* 

TM 2.6.7.1

*With:* 

TM 2.6.7.3

Table 7

*Replace row:*

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Paragraph</th>
<th>Test Method</th>
<th>D* or N</th>
<th>Class T</th>
<th>Class H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture and Insulation Resistance (comb pattern)</td>
<td>3.9.1</td>
<td>2.6.3.1</td>
<td>D</td>
<td>≥500 megohms (B-25A or B-25)</td>
<td>≥100 megohms (B-25A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>≥500 megohms (B-25)</td>
</tr>
</tbody>
</table>

**With:**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Paragraph</th>
<th>Test Method</th>
<th>D* or N</th>
<th>Class T</th>
<th>Class H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture and Insulation Resistance (comb pattern)</td>
<td>3.9.1</td>
<td>2.6.3.1</td>
<td>D</td>
<td>≥500 megohms (IPC-B-25A Board, Pattern E and F)</td>
<td>≥500 megohms (IPC-B-25A Board, Pattern D)</td>
</tr>
</tbody>
</table>

Thermal Shock Test Method

*Replace:* 

2.6.7.1

*With:* 

2.6.7.3

4.6.1 Inspection of Product for Delivery

*Replace:* 

IPC-RB-276

*With:* 

IPC-6011 and IPC-6012

4.7.1 Preparation Prior to Coating

*Replace:* 

TM 2.3.26, TM 2.3.26.1

*With:* 

TM 2.3.25.1