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DSCC-VAC

March 26, 2004

MEMORANDUM FOR MILITARY/INDUSTRY DISTRIBUTION

SUBJECT: Initial Draft of MIL-PRF-31032A, MIL-PRF-31032/1B, MIL-PRF-31032/2A, MIL-PRF-31032/3A, and MIL-PRF-31032/4A; Project Numbers 5998-0133, -0133-01, -0133-02, -0155, and -0156

The initial drafts for these subject documents, dated March 25, 2004, are now available for viewing and downloading from the DSCC-VA Web site:

<http://www.dsc.dla.mil/Programs/MilSpec/DocSearch.asp>

These documents are being revised to update all documents to current MIL-STD-961 requirements. Major changes to these document include the altering appendix A from guidance to mandatory, the addition of capability verification inspection in appendix C, and modifying the specification sheet requirements to align with the changes in MIL-PRF-31032.

If these documents are of interest to you, please submit your typed comments or suggestions using electronic mail or by letter. Comments or suggested changes that are not editorial in nature should include justification. Industrial activities should indicate whether they are commenting from the standpoint of a "User" or "Manufacturer." Military review activities should forward comments to their custodians in sufficient time to allow for consolidating the departmental reply. Navy review activities are requested to send comments to this center in lieu of the Navy - EC custodian. All agencies, industry, and coordinated custodian comments should be sent to this center. Comments originating from military departments must be identified as either "Essential" or "Suggested." Essential comments, which must be accepted or withdrawn, should be supported by supporting data unless they obviously require no data.

Concurrence or comments are required at this Center within 45 days from the date of this letter. Late comments will be held for the next coordination of the document. Any further coordination concerning these revisions will be circulated only to firms and organizations that furnish comments or reply that they have an interest.

The point of contact for this document is Mr. David Corbett, Defense Supply Center Columbus, DSCC-VAC, Post Office Box 3990, Columbus, OH 43216-5000. Mr. Corbett can also be reached at (614) 692-0526/850-0526, or by facsimile (614) 693-1642, or by e-mail to: 5998\_Documents@dsc.dla.mil.

/Signed/

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cc:  
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The document and process conversion measures necessary to comply with this revision shall be completed by (6 months from document date).

METRIC

MIL-PRF-31032/1B  
D R A F T  
SUPERSEDING  
MIL-PRF-31032/1A  
22 June 1999

## PERFORMANCE SPECIFICATION SHEET

### PRINTED WIRING BOARD, RIGID, MULTILAYERED, THERMOSETTING RESIN BASE MATERIAL, WITH OR WITHOUT BLIND AND BURIED PLATED THROUGH HOLES, FOR SOLDERED PART MOUNTING

This requirements for acquiring the product described herein shall consist of this specification sheet and MIL-PRF-31032.

#### 1. SCOPE

- \* 1.1 Scope. This specification covers the generic requirements for rigid, multilayered (3 or more conductor layers) printed wiring boards (hereafter designated printed board) with plated holes, that will use soldering for component/part mounting (see 6.1.1).
- 1.2 Classification. Printed boards are classified as rigid, type 3 (multilayer board without blind or buried vias), or type 4 (multilayer board with blind or buried vias), as specified (see 6.2).

#### 2. APPLICABLE DOCUMENTS

- \* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.
- \* 2.2 Government documents. The following specification forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

##### DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-31032 - Printed Circuit Board/Printed Wiring Board, General Specification for.

- \* (Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or [www.dodssp.daps.mil](http://www.dodssp.daps.mil) or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)
- \* 2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents are those cited in the solicitation or contract.

##### ASTM INTERNATIONAL (ASTM)

ASTM E345 - Standard Test Methods of Tension Testing of Metallic Foil.

(Application for copies should be addressed to the ASTM International, 1916 Race Street, Philadelphia, PA 19103-1187 or <http://www.astm.org>.)

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\* ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

J-STD-003	-	Solderability Tests for Printed Boards.
IPC-2221	-	Generic Standard for Printed Board Design.
IPC-2222	-	Sectional Design Standard for Rigid Organic Printed Boards.
IPC-TM-650	-	Test Methods Manual.

\* (Application for copies should be addressed to the Association Connecting Electronics Industry, 2215 Sanders Road, Suite 200 South, Northbrook, IL 60062-6135 or <http://www.ipc.org>.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Printed board detail requirements. Printed boards delivered under this specification shall be in accordance with the requirements as specified herein, and documented in the printed board procurement documentation.

3.1.1 Conflicting requirements. The order of precedence of conflicting requirements shall be in accordance with MIL-PRF-31032.

3.1.2 Reference to printed board procurement documentation. For the purposes of this specification, when the term "specified" is used without additional reference to a specific location or document, the intended reference shall be to the applicable printed board procurement documentation.

3.2 Qualification. Printed boards furnished under this specification shall be technologies that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2).

\* 3.3 Design (see 6.2). Printed boards shall be of the design specified. Unless otherwise specified, if individual design parameters are not specified in the printed board procurement documentation, then the baseline design parameters shall be as specified in IPC-2221 and IPC-2222, type 3 or type 4, performance class 3. Test coupons shall be as specified in the applicable design standard and shall reflect worst-case design conditions of the printed boards that they represent.

\* 3.4 Printed board materials. All materials used in the construction of compliant printed boards shall comply with the applicable specifications referenced in the printed board procurement documentation. If materials used in the production of printed boards are not specified, then it is the manufacturer's responsibility to use materials which will meet the performance requirements of this specification. Acceptance or approval of any printed board material shall not be construed as a guarantee of the acceptance of the completed printed board.

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- \* 3.5 External visual and dimensional requirements. The completed production printed boards, supporting test coupons, or qualification test specimens (hereafter referred to as printed board test specimens) shall conform to the requirements specified in 3.5.1 through 3.5.5.4, as applicable.

3.5.1 Base material.

- \* 3.5.1.1 Edges of base material. Burrs, chips, nicks, haloing, and other penetrations along the base material edges of completed printed boards shall be acceptable provided the defect does not reduce the edge spacing specified by more than 50 percent.

- \* 3.5.1.2 Surface imperfections. Surface imperfections (such as scratches, pits, dents, and cuts or exposed reinforcement material fibers) shall be acceptable providing the imperfections meet all of the following:

- a. The imperfections do not bridge between conductors.
- b. The dielectric spacing between the imperfection and a conductor is not reduced below the specified minimum conductor spacing requirements.

3.5.1.3 Subsurface imperfections. Subsurface imperfections (such as blistering, haloing, delamination, and foreign inclusions) shall be acceptable providing the imperfections meets the following:

- a. The imperfections do not bridge more than 25 percent of the distance between conductors and/or plated-through holes. No more than two percent of the printed board area on each side shall be affected.
- b. The imperfections do not reduce conductor or dielectric spacing below the specified minimum requirements.
- c. The imperfections do not propagate as a result of testing (such as rework simulation, thermal stress, or thermal shock).
- d. The longest dimension of any single imperfection is no greater than 0.80 mm (.0315 inch). In non-circuitry areas, the maximum size shall not be greater than 2 mm (.079 inch) in the longest dimension or 0.01 percent of the printed board area, maximum.

NOTE: Color variations or mottled appearance in bond enhancement treatments shall be acceptable.

3.5.2 Conductor pattern.

3.5.2.1 Annular ring, external. The external annular ring shall be as specified. Unless otherwise specified, the external annular ring may have in isolated areas a 20 percent reduction of the specified external annular ring due to defects such as pits, dents, nicks, or pinholes.

- \* 3.5.2.2 Bonding of conductor to base material and lifted lands. There shall be no peeling or lifting of any land or conductor patterns from the base material. The completed printed board shall not exhibit any lifted land. (Note: Limited lifted lands are allowed on the post-thermal stress, rework simulation, and thermal shock test specimens.)

3.5.2.3 Conductor imperfections. The conductor pattern shall contain no cracks, splits or tears. Unless otherwise specified, any combination of edge roughness, nicks, pinholes, cuts or scratches exposing the base material shall not reduce each conductor width by more than 20 percent of its minimum specified width. There shall be no occurrence of the 20 percent reductions greater than 13 mm (.51 inch) or 10 percent of a conductor length, whichever is less.

3.5.2.4 Conductor finish. The conductor finish shall be as specified.

3.5.2.4.1 Coverage. The conductor finish shall completely cover the exposed conductor pattern. Complete coverage does not apply to the vertical conductor edges.

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3.5.2.4.2 Whiskers. There shall be no whiskers of solder or other platings on the surface of the conductor pattern.

3.5.2.5 Conductor spacing. Conductor spacing shall be as specified.

3.5.2.6 Conductor width. Conductor width shall be as specified.

\* 3.5.3 Dimensions. The completed printed board shall meet the dimensional requirements (such as cutouts, overall thickness, periphery, etc.) specified.

3.5.4 Hole pattern accuracy. The size and location of the hole pattern in the printed board shall be as specified.

3.5.5 Solder resist. Unless otherwise specified, the solder resist conditions below shall apply.

\* 3.5.5.1 Coverage. Solder resist coverage imperfections (such as blisters, skips, and voids) shall be acceptable providing the following conditions are met:

- a. The solder resist imperfection shall not expose two adjacent conductors whose spacing is less than the electrical spacing required for the voltage range and environmental condition specified in the applicable design standard.
- b. In areas containing parallel conductors, the solder resist imperfection shall not expose two isolated conductors whose spacing is less than 0.5 mm (.020 inch) unless one of the conductors is a test point or other feature area which is purposely left uncoated for subsequent operations.
- c. The exposed conductor shall not be bare copper.
- d. The solder resist imperfection does not expose tented via holes.

3.5.5.2 Discoloration. Discoloration of metallic surfaces under the cured solder resist is acceptable.

3.5.5.3 Registration. The solder resist shall be registered to the land or terminal patterns in such a manner as to meet the requirements specified. If no requirements are specified, the following apply:

- a. Unless otherwise specified, solder resist shall not encroach onto surface mount lands.
- b. Solder resist misregistration onto plated-through component hole lands (plated-through holes to which solder connections are to be made) shall not reduce the external annular ring below the specified minimum requirements.
- c. Solder resist shall not encroach into plated-through hole barrels or onto other surface features (such as connector fingers or lands of unplated holes) to which solder connections will be made.
- d. Solder resist is permitted in plated-through holes or vias in which no lead is to be soldered.
- e. Test points which are intended for assembly testing shall be free of solder resist unless a partial coverage allowance is specified.

3.5.5.4 Thickness. Solder resist thickness shall be as specified.

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3.6 Microsection requirements. Printed board test specimens (production printed boards or test coupons) shall conform to the requirements in 3.6.1 through 3.6.11, as applicable (see figure 1). Blind and buried vias shall meet the requirements of plated-through holes.

3.6.1 Annular ring, internal. The minimum internal annular ring shall be as specified.

3.6.2 Conductor finish thickness (plating or coating). The plating or coating thickness of the conductor finish shall be as specified.

\* 3.6.3 Conductor thickness. The conductor thickness shall be as specified (see 3.1).

\* 3.6.3.1 Minimum external thickness (type 3 and internal thickness type 4). When a conductor thickness is specified, the external conductor thickness (copper foil and copper plating) shall be equal to or greater than the specified thickness. When a conductor thickness with tolerance is specified, the external conductor thickness (copper foil or copper foil and copper plating) shall be within the specified tolerance for the specified thickness.

\* 3.6.3.2 Minimum internal thickness (type 3). When the procurement documentation specifies a minimum conductor thickness for internal conductors, the resulting conductor shall be equal to or within the specified tolerance for the specified conductor thickness. If only a copper foil weight requirement is specified, a reduction in thickness up to 10 percent below the minimum allowable foil thickness specified by the applicable material specification shall be considered acceptable in order to accommodate a processing allowance for cleaning either by chemical or mechanical means.

3.6.4 Hole wall plating.

3.6.4.1 Copper plating thickness. Unless otherwise specified, the copper plating thickness shall be in accordance with the applicable design standard. Any copper plating thickness less than 80 percent of the specified thickness shall be treated as a void.

3.6.4.1.1 Copper plating voids. The copper plating in the plated-through hole shall not exhibit any void in excess of the following:

- a. There shall be no more than one plating void per panel, regardless of length or size.
- b. There shall be no plating void longer than five percent of the total printed board thickness.
- c. There shall be no plating voids evident at the interface of any conductive layer and plated hole wall.

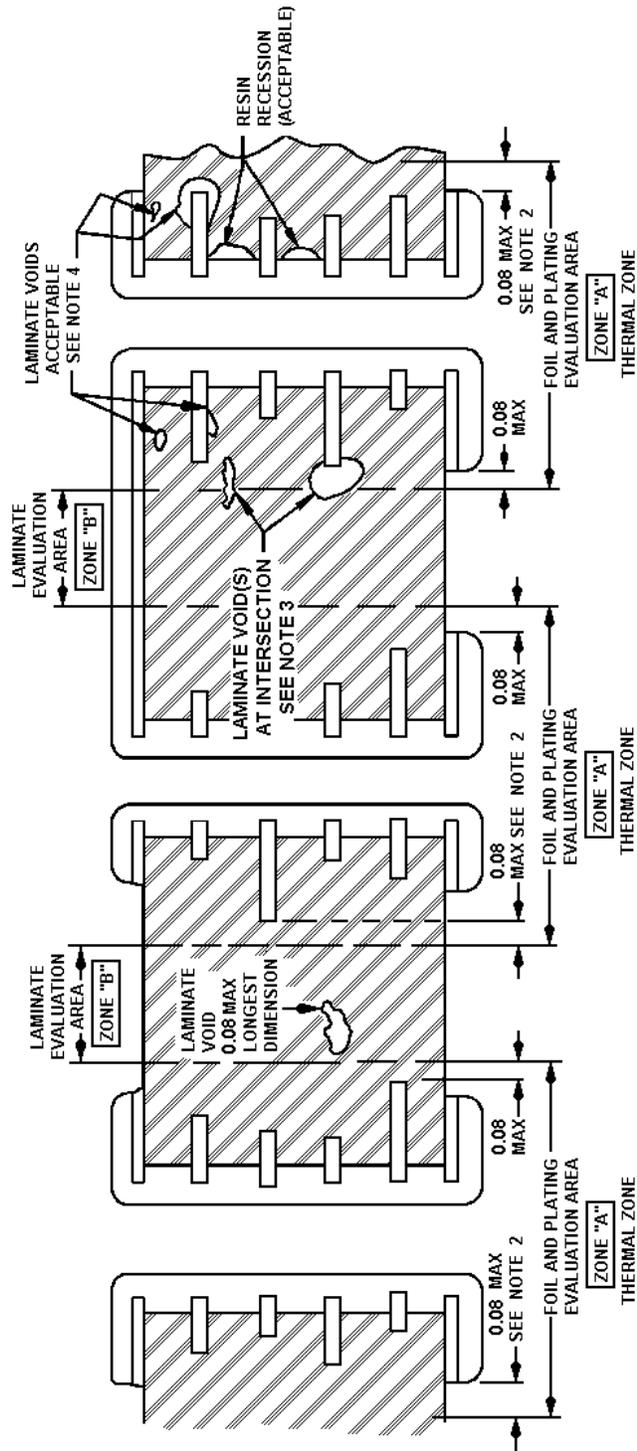
Conductor finish plating or coating material between the base material and copper plating (i.e., behind the hole wall copper plating) is evidence of a void. Any plated hole exhibiting this condition shall be counted as having one void for panel acceptance purposes.

\* 3.6.4.2 Copper plating defects. Nodules, plating folds, plating inclusions or plated reinforcement material protrusions that project into the plated-through hole shall be acceptable provided that the hole diameter and the copper thickness are not reduced below their specified limits.

3.6.4.3 Wicking. Wicking of copper plating extending 0.08 mm (.0031 inch) into the base material shall be acceptable provided it does not reduce the conductor spacing below the minimum clearance spacing requirements specified.

3.6.5 Metallic cracks. There shall be no cracks in the platings, coatings, or internal conductive foils. Cracks are permissible in the external layer (outer) copper foil provided they do not extend into the plated copper.

3.6.6 Dielectric layer thickness. The minimum dielectric thickness between conductor layers shall be as specified.



**NOTES:**

1. Dimensions are in millimeters.
2. Typically beyond land edge most radially extended.
3. Void at intersection of zone A and zone B. Laminate voids greater than 0.08 mm that extend into zone B are rejectable.
4. Laminate voids are not evaluated in zone A.

**FIGURE 1. Typical plated-through hole cross section after thermal stress or rework simulation.**

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\* 3.6.7 Etchback (when specified, see 3.1). When specified, printed boards shall be etched back for the lateral removal of base material (resin, reinforcement material, etc.) from the internal conductors prior to plating. The etchback shall be effective on at least the top or bottom surface of each internal conductor. Negative etchback is not acceptable when etchback is specified.

\* 3.6.7.1 Etchback limits. Unless otherwise specified, the etchback shall be 0.005 mm (.0002 inch) minimum and 0.076 mm (.003 inch) maximum when measured at the internal copper contact area protrusion.

\* 3.6.8 Smear removal. When etchback is not specified, the plated hole internal conductors shall be cleaned to be free of resin smear. When etchback is not specified, a negative etchback of 0.013 mm (.0005 inch) maximum shall be acceptable.

3.6.9 Conductive interface separations. Except for along the vertical edge of the external copper foil, there shall be no separations or contamination between the hole wall conductive interfaces. Conductive interface separations along the vertical edge of the external copper foil shall be acceptable. Anomalies resulting from this separation shall not be cause for rejection.

NOTE: The term conductive interfaces shall be used to describe the junction between the hole wall plating or coating and the surfaces of internal and external layers of copper or metal foil. The interface between platings and coating (electroless copper, direct metallization copper and non-electroless electroless copper substitutes, etc., and electrolytic copper, whether panel or pattern plated), shall also be considered a conductive interface.

3.6.10 Laminate voids. Laminate voids with the longest dimension of 0.08 mm (.0032 inch) or less shall be acceptable provided the conductor spacing is not reduced below the minimum dielectric spacing requirements, laterally or vertically, as specified. After undergoing rework simulation (see 3.7.4.5), thermal stress (see 3.7.6.2) or thermal shock (see 3.7.6.3), laminate voids are not evaluated in zone A (see figure 1).

\* 3.6.11 Lifted lands. After undergoing rework simulation (see 3.7.4.5), thermal stress (see 3.7.6.2) or thermal shock (see 3.7.6.3), the maximum allowed lifted land distance from the printed board surface to the outer lower edge of the land shall be the thickness (height) of the terminal area or land. The completed, non-stressed printed board shall not exhibit any lifted lands.

3.7 Performance requirements. The performance requirements specified in 3.7.1 through 3.7.6 shall be verified by the test methods detailed in 4.7. Unless otherwise specified, test optimization in accordance with MIL-PRF-31032 may be used, but the printed boards shall meet all of the performance requirements specified and herein, regardless of the verification method used.

\* 3.7.1 Acceptability (of printed boards). When examined as specified in 4.7.1, the printed boards shall conform to the acceptance requirements specified in 3.3 (design), 3.4 (material), 3.5 (external visual and dimensional), 3.8 (marking), and 3.9 (workmanship), inclusive.

\* 3.7.2 Microsection evaluation (of printed board test specimens). When printed board test specimens (completed printed boards, supporting test coupons, or qualification test specimens) are microsectioned and examined as specified in 4.7.2, the requirements specified in 3.6 shall be met.

3.7.3 Chemical requirements.

3.7.3.1 Cleanliness. When printed board test specimens are tested in accordance with 4.7.3.1, the levels of cleanliness shall be in accordance with the requirements of 3.7.3.1.1 or 3.7.3.1.2, as applicable.

3.7.3.1.1 Prior to the application of solder resist. Unless otherwise specified, prior to the application of solder resist, the level of ionic contamination shall not exceed 1.56 micrograms/square centimeter (10.06 micrograms/square inch).

3.7.3.1.2 Completed printed boards (when specified, see 3.1 and 6.2.1.a). The levels of cleanliness for completed printed boards shall be as specified.

3.7.3.2 Copper plating characteristics.

3.7.3.2.1 Elongation. When copper plating is tested in accordance with 4.7.3.2, the elongation shall be 6 percent minimum.

3.7.3.2.2 Tensile strength. When copper plating is tested in accordance with 4.7.3.3, the tensile strength shall be 248 MPa (36,000 psi) minimum.

3.7.4 Physical requirements.

\* 3.7.4.1 Adhesion, marking. After marking is tested in accordance with 4.7.4.1, any specified markings which are missing in whole or in part, faded, shifted (dislodged), or smeared to the extent that it is no longer legible shall constitute failure. A slight change in the color of ink or paint markings after the test shall be acceptable.

\* 3.7.4.2 Adhesion, plating. When tested as specified in 4.7.4.2, there shall be no part of the conductor pattern or copper plating protective finish (coating or plating) removed from the printed board test specimen except for those related to outgrowth, overhang, or slivers.

3.7.4.3 Adhesion, solder resist (when applicable). When tested as specified in 4.7.4.3, the maximum percentage of cured solder resist lifted from the surface of the base material, conductors, and lands of the coated printed board test specimen shall not exceed the following limits:

- a. Bare copper or base material: 0 percent.
- b. Non-melting metals (e.g., gold or nickel plating): 5 percent.
- c. Melting metals (e.g., tin-lead plating, solder coating, indium, bismuth, etc.): 10 percent.

3.7.4.4 Bow and twist. When printed boards are tested as specified in 4.7.4.4, the maximum limit for bow and twist shall be as specified.

3.7.4.5 Rework simulation. After undergoing the test specified in 4.7.4.5, the printed board test specimens shall be microsectioned and inspected in accordance with 4.7.2 and the requirements specified in 3.6 shall be met.

\* 3.7.4.6 Solderability (see 6.2.1.b). When required by the procurement documentation, accelerated conditioning for coating durability shall be in accordance with J-STD-003. The default category of coating durability of J-STD-003 is category 2.

3.7.4.6.1 Hole solderability. After undergoing the test specified in 4.7.4.6, the printed board test specimen shall conform to the class 3 acceptance criteria specified in J-STD-003.

3.7.4.6.2 Surface solderability. After undergoing the test specified in 4.7.4.6, the printed board test specimen shall conform to the class 3 acceptance criteria specified in J-STD-003.

3.7.5 Electrical requirements.

3.7.5.1 Continuity. When tested in accordance with 4.7.5.1, unless otherwise specified, there shall be no circuit whose resistance exceeds 10 ohms. For referee purposes, 0.5 ohm maximum per 25 mm (.98 inch) of circuit length shall apply.

3.7.5.2 Isolation (circuit shorts). When tested as specified in 4.7.5.2, the resistance between mutually isolated conductors shall be greater than 2 megohms.

3.7.6 Environmental requirements.

3.7.6.1 Moisture and insulation resistance. When tested as specified in 4.7.6.1, the printed board test specimen shall have a minimum of 500 megohms of resistance between conductors. After the test, the printed board test specimen shall not exhibit blistering, measling or delamination in excess of that allowed in 3.5.1.

3.7.6.2 Thermal stress. After undergoing the test specified in 4.7.6.2, the printed board test specimen shall be inspected in accordance with 4.7.2 and shall meet the requirements of 3.6.

3.7.6.3 Thermal shock. After undergoing the test specified in 4.7.6.3, the printed board test specimens shall meet the following requirements:

- a. Visual inspection: When inspected as specified in 4.7.1, there shall be no evidence of plating cracks, blistering, crazing, or delamination in excess of that allowed in 3.5.
- \* b. Resistance change: The change in resistance between the first high temperature cycle and the last high temperature cycle shall not be more than 10 percent.
- c. Microsection: The printed board test specimen shall be microsectioned and inspected in accordance with 4.7.2 and the requirements specified in 3.6 shall be met.

3.8 Marking. Marking shall be in accordance with MIL-PRF-31032.

- \* 3.9 Workmanship. Printed boards shall be processed in such a manner as to be uniform in quality and shall be free from defects that will affect life, serviceability, or appearance.

4. VERIFICATION

- \* 4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:
  - \* a. Qualification inspection (see 4.2).
  - \* b. Conformance inspection (see 4.3 and tables I and II).
  - \* c. Capability verification inspection (see 4.6).

4.1.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-PRF-31032, and as specified herein.

4.1.2 Standard test and inspection conditions. Unless otherwise specified by the applicable test method or procedure, inspections and tests may be performed at ambient conditions.

4.2 Qualification inspection. Unless otherwise specified by the TRB approved qualification test plan, qualification inspection shall be in accordance with MIL-PRF-31032 and as specified herein.

4.2.1 Qualification test vehicles. The qualification test vehicle(s) to be subjected to qualification inspection shall be in accordance with the TRB approved qualification test plan and the applicable qualification test vehicle specification(s).

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4.2.1.1 Sample. The number of qualification test vehicle(s) to be subjected to qualification inspection shall in accordance with TRB approved qualification test plan.

- \* 4.2.2 Test routine. The qualification test vehicle(s) shall be subjected to the inspections and tests specified in tables I and II in addition to thermal shock in accordance with 3.7.6.3 and 4.7.6.3.
- \* 4.2.3 Qualification by similarity. A production lot may be considered qualified by similarity if the dimensional parameters are within twenty-five percent of those currently qualified and the processing steps used are a set or subset of those processes used for a previous qualified technology.
- \* 4.3 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-31032 and shall consist of lot conformance inspection (see 4.4) and periodic conformance inspection (see 4.5).
- \* 4.4 Lot conformance inspection. Lot conformance inspection shall be in accordance with MIL-PRF-31032 and table I herein. Panels and or printed boards to be delivered in accordance with this specification shall have been subjected to and passed all applicable inspections and tests of table I prior to delivery of product. Lot conformance inspection testing by subgroup or within a subgroup may be performed in any sequence.
  - \* 4.4.1 Subgroup 1 inspections (panel acceptance). The panel acceptance test shall be in accordance with MIL-PRF-31032, and as specified in table I, subgroup 1.
    - \* 4.4.1.1 Sampling, type 3 designs. A minimum of two test coupons (one A and one B test coupon) per panel shall be tested for type 3 designs. The two test coupons shall be taken from opposite corners of the panel. After the test, one of the test coupon shall be microsectioned in the panel's length (X direction) and the other shall be microsectioned along the panel's width (Y direction).
    - \* 4.4.1.2 Sampling, type 4 designs. A minimum of two test coupons per composite shall be tested for completed type 4 designs. The two test coupons shall be taken from opposite corners of the composite. After the test, one of the test coupon shall be microsectioned in the panel's length (X direction) and the other shall be microsectioned along the panel's width (Y direction). In addition, type 4 printed boards shall have one additional non-thermal stressed microsections for each plating process used. See 6.4 for additional guidance.
      - 4.4.1.3 PDA limits. The PDA limits for panel acceptance shall be 32 percent.
    - \* 4.4.1.4 Failure mode observations. If the microsection evaluation results indicate a potential failure mode in the non-stressed printed board test specimens (i.e., propagation of subsurface imperfections, lifted lands within post-thermal stress acceptance criteria, etc.), additional microsection examination of non-stressed test specimens shall be performed.
      - 4.4.2 Subgroup 2 inspections (100 percent tests). The 100 percent tests shall be in accordance with MIL-PRF-31032, and as specified in table I, subgroup 2.
        - \* 4.4.2.1 PDA limits. The PDA limits for 100 percent inspection shall be 50 percent.
      - \* 4.4.3 Subgroup 3 inspections (sample). Panels and printed boards to be delivered in accordance with this specification shall have been subjected to and passed all the inspections of table I, subgroups 3a, 3b, and 3c.
        - 4.4.3.1 Sampling. A sample of printed boards (or test coupons that represent the printed boards) shall be randomly selected from each inspection lot.
          - \* 4.4.3.1 PDA limits. When 100 percent inspection is used either in lieu of sampling or due to rejection of a sample inspection lot, the PDA limits for this 100 percent inspection shall be 50 percent.

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TABLE I. Lot conformance inspection.

Inspection	Requirement paragraph	Method paragraph	Specimen to test <u>1/</u>				Sample plan <u>2/</u>
			PWB	THM	SMT	MIX	
Subgroup 1 (panel acceptance)							
Thermal stress	3.7.6.2	4.7.6.2		A & B	A & B	A & B	See 4.4.1.1
Subgroup 2 (100 percent)							
Continuity	3.7.5.1	4.7.5.1	X				100 percent
Isolation (circuit shorts)	3.7.5.2	4.7.5.2	X				100 percent
Subgroup 3a (Sample)							
Acceptability: <u>3/</u> <u>4/</u>							
Design	3.3	4.7.1	X				Plan BH
Material	3.4	4.7.1	X				Plan BH
Visual & dimensional	3.5	4.7.1	X				Plan BH
Marking	3.8	4.7.1	X				Plan BH
Workmanship	3.9	4.7.1	X				Plan BH
Subgroup 3b (Sample)							
Chemical:							
Cleanliness <u>5/</u>	3.7.3.1.1	4.7.3.1	X				Plan BN or TN <u>6/</u>
Subgroup 3c (Sample)							
Physical:							
Adhesion, marking	3.7.4.1	4.7.4.1	X	<u>7/</u>	<u>7/</u>	<u>7/</u>	Plan BH or TJ <u>6/</u>
Adhesion, plating <u>5/</u>	3.7.4.2	4.7.4.2	X	C	C	C	Plan BH or TJ <u>6/</u>
Adhesion, solder resist	3.7.4.3	4.7.4.3	X	G	G <u>8/</u>	G <u>8/</u>	Plan BH or TJ <u>6/</u>
Bow and twist	3.7.4.4	4.7.4.4	X				Plan BH
Solderability							
Hole	3.7.4.6.1	4.7.4.6		S or A		A or S	Plan TJ
Surface	3.7.4.6.2	4.7.4.6			C or M	C or M	Plan TJ

1/ Test coupons are in accordance with IPC-2221. PWB is a production board; THM is a through-hole mount test coupon; SMT is a surface mount PWB test coupon; MIX is a Mixed mounting test coupon.

2/ See MIL-PRF-31032 for C = 0 sampling plans.

3/ Design (3.3), conductor spacing (3.5.2.5), conductor width (3.5.2.6), conductor imperfections (3.5.2.3) and workmanship (3.9) shall be inspected on both the internal layers containing conductors prior to lamination and the completed printed board.

4/ Surface imperfections (3.5.1.2) and subsurface imperfections (3.5.1.3) shall be inspected prior to solder resist application.

5/ Inspection shall be performed prior to solder resist application. All surface platings or coatings shall be inspected. Additional inspections on completed printed boards may be specified.

6/ Test coupon, production panel, or production printed board, manufacturer option.

7/ See 4.7.4.1.

8/ Test coupon T shall be used when production printed boards have tented via holes.

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- \* 4.5 Periodic conformance inspection. Periodic conformance inspection shall be in accordance with TRB approved periodic conformance inspection plan and table II herein.
- \* 4.5.1 Sampling. Sample units shall be selected randomly from the most complex printed board inspection lot that has passed all the lot conformance inspections during that production month. The method for determining the most complex printed board shall as described in the manufacturer's TRB approved quality management plan (see MIL-PRF-31032).

TABLE II. Periodic conformance inspection baseline test coverage.

Inspection	Requirement paragraph	Method paragraph
Elongation	3.7.3.2.1	4.7.3.2
Tensile strength	3.7.3.2.2	4.7.3.3
Rework simulation <u>1/</u>	3.7.4.5 <u>1/</u>	4.7.4.5 <u>1/</u>
Moisture and insulation resistance	3.7.6.1	4.7.6.1

- \* 1/ Thermal stress in accordance with 3.7.6.2 and 4.7.6.2 shall be used in lieu of rework simulation when via only design represent the most complex technology for the reporting period.
- \* 4.6 Capability verification inspection. Capability verification inspection shall be in accordance with the TRB approved capability verification inspection plan. The frequency of this verification shall be as a minimum every 2 years. Each base material type qualified shall be verified. The following tests and inspections should be considered when accomplishing capability verification inspection: thermal shock, rework simulation, moisture and insulation resistance testing.
  - 4.7 Methods of inspection.
    - 4.7.1 Visual and dimensional inspection. The printed board specimen shall be inspected in accordance with test method number 2.1.8 of IPC-TM-650, except that the magnification shall be 1.75x (3 diopters), minimum.
    - 4.7.2 Microsection inspection. Microsection inspections shall be accomplished by using methods in accordance with either test method number 2.1.1 or 2.1.2.1 of IPC-TM-650. Referee inspections shall be accomplished at a magnification of 200x.
    - 4.7.3 Chemical test methods.
      - \* 4.7.3.1 Cleanliness. The printed board specimen shall be inspected for ionic cleanliness in accordance with test method number 2.3.25 of IPC-TM-650.
      - \* 4.7.3.2 Elongation of copper. The test for elongation of copper shall be performed in accordance with ASTM E345. The travel speed of testing shall be 50 mm ± 1 mm (1.97 ± .03 inches) per minute.
      - \* 4.7.3.3 Tensile strength of copper. The test for tensile strength of copper shall be performed in accordance with ASTM E345. The travel speed of testing shall be 50 mm ± 1 mm (1.97 ± .03 inches) per minute.

#### 4.7.4 Physical test methods.

4.7.4.1 Adhesion, marking. Test specimens which represent all types of marking used on the lot (except etched marking) shall be subjected to the solderability test in 4.7.4.8. The side of the test specimen that is marked shall be placed against the solder. After the test, the test specimen shall be examined in accordance with 4.7.1 and the requirements of 3.7.4.1 shall be met.

\* 4.7.4.2 Adhesion, plating. The test for plating adhesion shall be performed in accordance with test method number 2.4.1 of IPC-TM-650. If overhanging metal break off and adheres to the tape, it is evidence of outgrowth, overhang or slivers, but not of plating adhesion failure.

4.7.4.3 Adhesion, solder resist. The test for solder resist adhesion shall be performed in accordance with test method number 2.4.28.1 of IPC-TM-650,.

4.7.4.4 Bow and twist. The tests for bow and twist shall be performed in accordance with test method number 2.4.22 of IPC-TM-650.

4.7.4.5 Rework simulation. The rework simulation test shall be performed in accordance with test method number 2.4.36 of IPC-TM-650.

4.7.4.6 Solderability. The tests for hole or surface solderability shall be performed in accordance with J-STD-003.

#### 4.7.5 Electrical test methods.

4.7.5.1 Continuity. A current shall be passed through each conductor or group of interconnected conductors by applying electrodes on the terminals at each end of the conductor or group of conductors. The current passed through the conductors shall not exceed those specified in the applicable design standard for the smallest conductor in the circuit.

4.7.5.2 Isolation (circuit shorts). A test voltage shall be applied between all common portions of each conductor pattern and all adjacent common portions of each conductor pattern. The test voltage shall be applied between conductor patterns of each layer and the electrically isolated pattern of each adjacent layer. For manual testing the test voltage shall be 200 volts minimum and shall be applied for a minimum of 5 seconds. When automated test equipment is used, the minimum applied test voltage shall be the maximum rated voltage specified. If the maximum rated voltage on the printed board is not specified, the test voltage shall be 40 volts minimum.

#### 4.7.6 Environmental test methods.

4.7.6.1 Moisture and insulation resistance. The test for moisture and insulation resistance shall be performed in accordance with class 3 of test method number 2.6.3 of IPC-TM-650.

\* 4.7.6.2 Thermal stress. The test for thermal stress shall be performed in accordance with condition A of test method number 2.6.8 of IPC-TM-650.

4.7.6.3 Thermal shock. The test for thermal shock shall be performed in accordance with test method number 2.6.7.2 of IPC-TM-650 except that the temperature extremes shall be -65 degrees Celsius and +125 degree Celsius.

### 5. PACKAGING

5.1 Packaging requirement. The requirement for packaging shall be in accordance with MIL-PRF-31032.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-31032 are applicable to this specification.

- \* 6.1.1 Intended use. This associated specification was developed for the use of verifying the performance of rigid, woven E-glass reinforced, thermosetting resin base materials, multilayered (3 or more conductor layers) printed boards with plated holes (with or without blind or buried vias), that will use soldering for component mounting. Printed boards of other base material types or construction styles can be tested or verified to the performance requirements contained in this document, however, the performance parameters of other associated specifications may be more appropriate.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- \* a. Title, number, revision letter and date of this specification.
- \* b. The specific issues of individual documents referenced (see section 2).
- c. Title, number and date of applicable printed board procurement documentation or drawing and identification of the originating design activity.
- \* d. The complete product procurement documentation part or identifying number (see 3.1).
- e. Title, number, revision letter (with amendment number when applicable) and date of the applicable design standard with classification (printed board type, performance class, etc.).
- f. Requirements for delivery of one copy of the quality conformance inspection data pertinent to the product inspection lot to be supplied with each shipment by the QML manufacturer, if applicable.
- g. Requirements for certificate of compliance, if applicable.
- h. Requirements for notification of change of product or process to the contracting activity in addition to notification to the qualifying activity, if applicable.
- k. Levels of preservation and packing required.
- l. If special or additional identification marking is required (see 3.8).
- \* m. Government approved deviation list for printed board procurement documentation, if applicable.

6.2.1 Optional acquisition data. The following items are optional and are only applicable when specified in the printed board procurement documentation.

- a. If any special or additional cleanliness is required (see 3.7.3.1.2).
- b. The durability of coating rating (accelerated aging for solderability testing) if other than category 2 (see J-STD-003).
- c. Requirements for failure analysis, corrective action and reporting of results.
- d. Disposition of lot conformance inspection sample units.
- e. Any other special requirements.

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\* 6.3 Replacement information. This specification includes a majority of the performance requirements of previous revisions of MIL-P-55110 and MIL-PRF-55110 for type 3 printed wiring boards constructed using woven glass reinforced epoxy or polyimide resin base material (legacy types GB, GE, GF, GH, GM, and GI). Printed wiring boards conforming to this associated specification would be comparable to printed wiring boards conforming to MIL-P-55110 or MIL-PRF-55110.

\* 6.4 Blind or buried vias. This specification includes provisions for verifying the performance of type 4 rigid printed wiring boards.

6.5 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:  
Army - CR  
Navy - EC  
Air Force - 11  
DLA - CC

Preparing activity:  
DLA - CC  
  
(Project 5998-0155)

Review activities:  
Army - MI  
Navy - CG  
Air Force - 99

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