

## PERFORMANCE SPECIFICATION

PRINTED WIRING BOARD, RIGID, MULTILAYERED,  
WOVEN E-GLASS REINFORCED THERMOSETTING RESIN BASE MATERIAL,  
WITH PLATED THROUGH HOLES, FOR SOLDERED PART MOUNTING

This specification is approved for use by all Departments and Agencies of the Department of Defense

## 1 SCOPE

1.1 Statement of scope This specification covers the generic requirements for rigid, multilayered (3 or more conductor layers) printed wiring boards with plated holes, that will use soldering for component/part mounting (see 6.1.1)

1.2 Classification Printed wiring boards are classified as rigid, type 3 (multilayer board without blind or buried vias), as specified (see 6.2.2)

## 2 APPLICABLE DOCUMENTS

2.1 General The documents listed in this section are specified in sections 3 and 4 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 requirement documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government specifications The following specifications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

## SPECIFICATIONS

## DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specification is available from the Defense Printing Services Detachment Office, Building 4D (Customer Service), 700 Tabor Avenue, 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 which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E345 - Standard Test Methods of Tension Testing of Metallic Foils

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187)

## INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

- J-STD-003 - Solderability Tests for Printed Boards
- IPC-D-275 - Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies
- IPC-TM-650 - Test Methods Manual

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 2215 Sanders Road, Northbrook, IL 60062-6135 )

(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 wiring 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 wiring 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 4.3).

3.3 Design (see 6.2.2.1) Printed wiring boards shall be of the design specified. Unless otherwise specified, if individual design parameters are not specified, then the baseline design parameters shall be as specified by IPC-D-275, type 3, class 3. Test coupons shall be as specified in the applicable design standard and shall reflect worst case design conditions.

3.4 Printed board materials All materials used in the construction of compliant printed wiring boards shall comply with the applicable specifications referenced in the printed board procurement documentation. If materials needed in the production of printed wiring 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 finished printed wiring board.

3.5 Visual and dimensional requirements The printed wiring board test specimens (production printed wiring boards or test coupons) shall conform to the requirements specified in 3.5.1 through 3.5.6, as applicable.

#### 3.5.1 Base material

3.5.1.1 Edges of base material Burrs, chips, nicks, halos, and other penetrations along the base material edges of finished printed wiring 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 provided 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, halos, 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 wiring 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 (0.0315 inch). In non-circuitry areas, the maximum size shall not be greater than 2 mm (0.079 inch) in the longest dimension or 0.01 percent of the printed wiring 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** Unless otherwise specified, there shall be no peeling or lifting of any conductor from the base material.

**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 (0.51 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.

**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 finished printed wiring board shall meet the dimensional requirements specified.

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

**3.5.5 Lifted lands** The finished printed wiring board shall not exhibit any lifted lands.

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

**3.5.6.1 Coverage** Solder resist coverage imperfections (such as blisters, skips, and voids) shall be acceptable providing the imperfection meets all of the following:

- 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 (0.020 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 6 2 Discoloration Discoloration of metallic surfaces under the cured solder resist is acceptable

3 5 6 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 vias or holes 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 6 4 Thickness Solder resist thickness shall be as specified

3 6 Microsection requirements Printed wiring board test specimens (production printed wiring boards or test coupons) shall conform to the requirements in 3 6 1 through 3 6 11, as applicable (see figure 1)

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 on printed wiring boards shall be as specified. If only a starting metal foil weight is specified, the minimum conductor thickness (metal foil or metal foil and metal plating, as applicable) shall not be reduced below 10 percent of the starting foil thickness

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 wiring board thickness
- c There shall be no plating voids evident at the interface of any conductive layer and plated hole wall

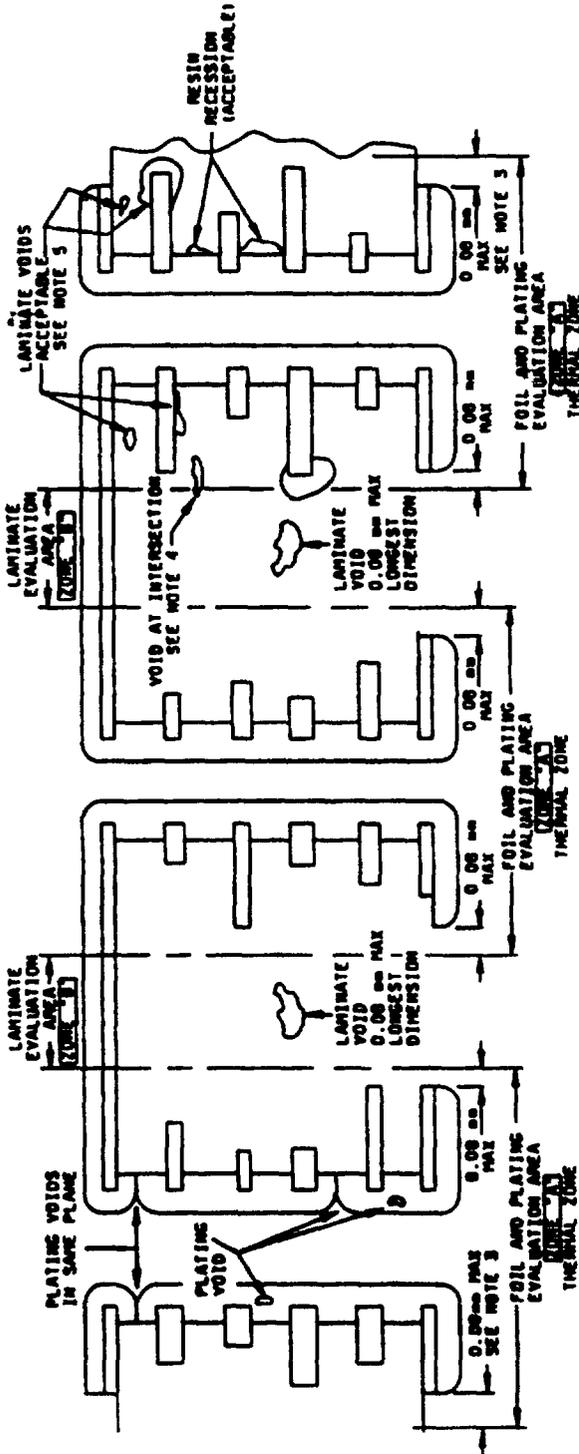
Conductor finish plating or coating material between the base material and copper plating (i.e., behind the hole wall copper plating) is evidence of a void. Any plated hole exhibiting this condition shall be counted as having one void for panel acceptance purposes

3 6 4 2 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. Inches equivalents are given for general information only.
3. Typically beyond land edge most radially extended
4. Void at intersection of zone A and zone B Laminate voids greater than 0.08 mm (.003) that extend into zone B are rejectable.
5. Laminate voids are not evaluated in zone A Laminate voids greater than 0.08 mm (.003) that extend into zone B are rejectable.

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

**3 6 7 Etchback (when specified, see 3.1)** When specified, printed wiring boards shall be etched back for the lateral removal of resin and glass fibers 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 with a preferred depth of 0 015 mm (0006 inch).

**3 6 8 Smear removal** When etchback is not specified, the plated-through hole 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 metalization 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 wiring board surface to the outer lower edge of the land shall be the thickness (height) of the terminal area or land. The finished, non-stressed printed wiring 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 6. Unless otherwise specified, test optimization in accordance with MIL-PRF-31032 may be used, but the printed wiring boards shall meet all of the performance requirements specified and herein, regardless of the verification method used.

**3 7 1 Acceptability (of printed wiring boards)** When examined as specified in 4 6 1, the printed wiring boards shall be in accordance with the acceptance requirements specified in 3 3 (design), 3 4 (material), 3 5 (visual and dimensional), 3 8 (marking), and 3 9 (workmanship).

**3 7 2 Microsection evaluation (of printed wiring test specimens)** When printed wiring board test specimens (finished printed wiring boards, supporting test coupons, or qualification test specimens) are microsectioned and examined as specified in 4 6 2, the requirements specified in 3 6 shall be met.

### 3 7 3 Chemical requirements

**3 7 3 1 Cleanliness** When printed wiring board test specimens are tested in accordance with 4 6 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 wiring boards (when specified, see 3.1 and 6.2.1a)** The levels of cleanliness for completed printed wiring 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 6 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 6 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 6 4 1, any specified markings which are missing in whole or in part, faded, smeared, or shifted (dislodged) to the extent that they cannot be readily identified 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 6 4 2, there shall be no plating particles or conductor patterns removed from the printed wiring board test specimen except for outgrowth.

3 7 4 3 Adhesion solder resist (when applicable) When tested as specified in 4 6 4 3, the maximum percentage of cured solder resist lifted from the surface of the base material, conductors, and lands of the coated printed wiring 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 wiring boards are tested as specified in 4 6 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 6 4 5, the printed wiring board test specimens shall be microsectioned and inspected in accordance with 4 6 2 and the requirements specified in 3 6 shall be met.

### 3 7 4 6 Solderability (see 6.2.1b)

3 7 4 6 1 Hole solderability After undergoing the test specified in 4 6 4 6, the printed wiring 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 6 4 6, the printed wiring 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 6 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 6 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 6 6 1, the printed wiring board test specimen shall have a minimum of 500 megohms of resistance between conductors. After the test, the printed wiring board test specimen shall not exhibit blistering, measing or delamination in excess of that allowed in 3 5 1.

3 7 6 2 Thermal stress After undergoing the test specified in 4 6 6 2, the printed wiring board test specimen shall be inspected in accordance with 4 6 2 and shall meet the requirements of 3 6.

3 7 6 3 Thermal shock After undergoing the test specified in 4 6 6 3, the printed wiring board test specimens shall meet the following requirements:

- a Visual inspection When inspected as specified in 4 6 1, there shall be no evidence of plating cracks, blistering, crazing, or delamination in excess of that allowed in 3 5.
- b Continuity When tested as specified in 4 6 5 1, 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 wiring board test specimen shall be microsectioned and inspected in accordance with 4 6 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 wiring 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 Sampling and inspection Sampling and inspection shall be in accordance with MIL-PRF-31032, and as specified herein

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

4.3 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

4.3.1 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)

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

4.3.2 Test routine The qualification test vehicle(s) shall be subjected to the inspections and tests specified in tables I and II

4.3.3 Qualification by similarity A production lot may be considered qualified by similarity if the dimension parameters are within twenty-five percent of that which is currently qualified. This window is applicable on an associated specification basis

4.4 Lot conformance inspection Lot conformance inspection shall be in accordance with MIL-PRF-31032 and table I herein. Lot conformance inspection testing by subgroup or within a subgroup may be performed in any sequence

4.4.1 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 A minimum of two test coupons per panel shall be tested. 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 PDA limits The PDA limits for panel acceptance shall be 32 percent

4.4.2 100 percent inspection 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 Sample inspections Panels and printed wiring boards to be delivered in accordance with this specification shall have been subjected to and passed all the inspections of table I, subgroup 3

4.4.3.1 Sampling A sample of printed wiring boards (or test coupons that represent the printed wiring boards) shall be randomly selected from each inspection lot

TABLE I Lot conformance inspection

Inspection	Requirement paragraph	Method paragraph	Specimen to test 1/				Sample plan 2/
			PWB	THM	SMT	MIX	
Subgroup 1 (panel acceptance)							
Thermal stress	3 7 6 2	4 6 6 2		B	B	B	See 4 4.1 1
Subgroup 2 (100 percent)							
Continuity	3 7 5 1	4 6 5 1	X				100 percent
Isolation (circuit shorts)	3 7 5 2	4 6 5 2	X				100 percent

See footnotes at the end of table

TABLE I Lot conformance inspection - Continued

Inspection	Requirement paragraph	Method paragraph	Specimen to test 1/				Sample plan 2/
			PWB	THM	SMT	MIX	
Subgroup 3a (Sample)							
Acceptability 3/ 4/							
Design	3 3	4 6 1	X				Plan BH
Material	3 4	4 6 1	X				Plan BH
Visual & dimensional	3 5	4 6 1	X				Plan BH
Marking	3 8	4 6 1	X				Plan BH
Workmanship	3 9	4 6 1	X				Plan BH
Subgroup 3b							
Chemical							
Cleanliness 5/	3 7 3 1 1	4 6 3 1	X				Plan *N
Subgroup 3c							
Physical							
Adhesion, marking	3 7 4 1	4 6 4 1	X	6/	6/	6/	Z/
Adhesion, plating 5/	3 7 4 2	4 6 4 2	X	C	C	C	Z/
Adhesion, solder resist	3 7 4 3	4 6 4 3	X	G	G 6/	G 6/	Z/
Bow and twist	3 7 4 4	4 6 4 4	X				Plan BH
Solderability							
Hole	3 7 4 6 1	4 6 4 6		A or S		A or S	Plan TJ
Surface	3 7 4 6 2	4 6 4 6			C or M	C or M	Plan TJ

1/ Test coupons are in accordance with IPC-D-275 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 wiring 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. Additional inspections on completed printed wiring boards may be specified

6/ See 4 6 4 1

Z/ Test coupon (sample plan TJ) or production printed wiring board (sample plan BH), manufacturer option

6/ Test coupon T shall be used when production printed wiring boards have tented via holes

4.5 Periodic conformance inspection Periodic conformance inspection shall be in accordance with MIL-PRF-31032 and table II herein

TABLE II Periodic conformance inspection baseline test coverage

Inspection	Requirement paragraph	Method paragraph	Tests frequency
Elongation	3 7 3 2 1	4 6 3 2	Monthly
Tensile strength	3 7 3 2 2	4 6 3 3	Monthly
Rework simulation	3 7 4 5	4 6 4 5	Monthly
Moisture and insulation resistance	3 7 6 1	4 6 6 1	Monthly
Thermal shock	3 7 6 3	4 6 6 3	Annually

#### 4.6 Methods of inspection

4.6.1 Visual and dimensional inspection The printed wiring board specimen shall be inspected in accordance with IPC-TM-650, method 2.1.8, except that the magnification shall be 1.75x (3 diopters), minimum

4.6.2 Microsection inspection Microsection inspections shall be accomplished by using methods in accordance with either IPC-TM-650, method 2.1.1 or 2.1.2. Referee inspections shall be accomplished at a magnification of 200x

#### 4.6.3 Chemical test methods

4.6.3.1 Cleanliness The sodium chloride (NaCl) salt equivalent ionic contamination tests of 4.6.3.1.1, 4.6.3.1.2, or 4.6.3.1.3 shall be used to test for ionic cleanliness

4.6.3.1.1 Manual method The test for cleanliness shall be performed in accordance with IPC-TM-650, method 2.3.25

4.6.3.1.2 Automatic methods The test for cleanliness shall be performed in accordance with IPC-TM-650, method 2.3.26 or 2.3.26.1

4.6.3.1.3 Alternate automatic methods The sodium chloride salt equivalent ionic contamination test equipment specified in 6.3 may be used in lieu of the methods specified in 4.6.3.1.1 or 4.6.3.1.2. When printed wiring boards are tested using the sodium chloride salt equivalent ionic contamination test equipment specified in 6.3, the final value shall be less than equivalents of sodium chloride specified in table III for the printed wiring board surface area tested

4.6.3.2 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 ± 0.03 inches) per minute. Samples shall be baked for 6 hours minimum at 135°C (275°F) minimum prior to testing

4.6.3.3 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 ± 0.03 inches) per minute. Samples shall be baked for 6 hours minimum at 135°C (275°F) minimum prior to testing

#### 4.6.4 Physical test methods

4.6.4.1 Adhesion marking Test specimens which represent all type of marking used on the lot (except etched marking) shall be subjected to the solderability test in 4.6.4.6. 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 4.6.1 and the requirements of 3.7.4.1 shall be met.

4.6.4.2 Adhesion plating The test for plating adhesion shall be performed in accordance with IPC-TM-650, method 2.4.1

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

4.6.4.4 Bow and twist The tests for bow and twist shall be performed in accordance with IPC-TM-650, method 2.4.22

4.6.4.5 Rework simulation The rework simulation test shall be performed in accordance with IPC-TM-650, method 2.4.36

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

#### 4.6.5 Electrical test methods

4.6.5.1 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

4.6.5.2 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 voltage shall be applied between conductor patterns of each layer and the electrically isolated pattern of each adjacent layer. For manual testing the 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 as specified. If the maximum rated voltage on the printed wiring board is not specified, the test voltage shall be 40 volts minimum

#### 4.6.6 Environmental test methods

4.6.6.1 Moisture and insulation resistance The test for moisture and insulation resistance shall be performed in accordance with IPC-TM-650, method 2.6.3, class 3

4.6.6.2 Thermal stress The test for thermal stress shall be performed in accordance with IPC-TM-650, method 2.6.8

4.6.6.3 Thermal shock. The test for thermal shock shall be performed in accordance with IPC-TM-650, method 2.6.7.2 except that the temperature extremes shall be -65°C and +125°C

### 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 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 wiring boards with plated holes (without blind or buried vias), that will use soldering for component mounting. Printed wiring 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. The supplement for MIL-PRF-31032 contains a list of all known and current associated specifications at the time of its date and should be consulted for selection of the appropriate associated specification.

6.2 Acquisition requirements Acquisition documents must specify the following

- a Title, number, and date of this specification (with any amendments)
- b Issue of DODISS to be cited in the solicitation and, if required, the specific issue 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 number (see 3.1)
- e The printed wiring board classification (see 1.2 or 6.2.2)
- 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)

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

6 2 2 Optional classification

6 2 2 1 Design standard The design standard options are identified as follows

- C - Multilayer rigid printed wiring in accordance with customers design guidelines
- N - Type 3 in accordance with IPC-D-275, class 3

6 2 2 2 Number of conductor layers The number of conductor layers is identified by a two digit number, either 03, 04, 05, etc that designated the total number of all conductor or metal layers in the printed wiring board

6 2 2 3 Part mounting The techniques for mounting of the electronic components onto the printed wiring board during circuit card assembly are identified as follows

- A - Through-hole mounting (THM) of electronic components
- B - Surface mounting (SMT) of electronic components
- C - Mixed mounting (combinations of A and B, though-hole and surface mount) of components

6 2 2 4 Base material identifier The base material is identified by two letters that identify the base material type

6 2 2 4 1 Base material resin system modifier If there are base material resin system modifiers, they are identified by a single character that identifies the base material resin modification

6 2 2 5 Conductor finish (exposed conductors only) The finish of exposed conductors is identified by any of the characters as follows

- B - Bismuth (SMT part mounting only)
- C - Chemical, non-metallic coating
- D - Indium (SMT part mounting only)
- E - Either fused electrodeposited tin-lead or hot air leveled solder coating (F or H)
- F - Fused electrodeposited tin-lead plating
- G - Gold
- H - Hot air leveled solder coating
- M - Nickel (electrolytic)
- N - Nickel (electroless)
- \* - As specified in the printed board procurement documentation (see 3 1)
- R - Rhodium
- U - Non-fused electrodeposited tin-lead

6 2 2 6 Plated hole processing The type of hole preparation and the plating to be used are in accordance with 6 2 2 6 1 and 6 2 2 6 2

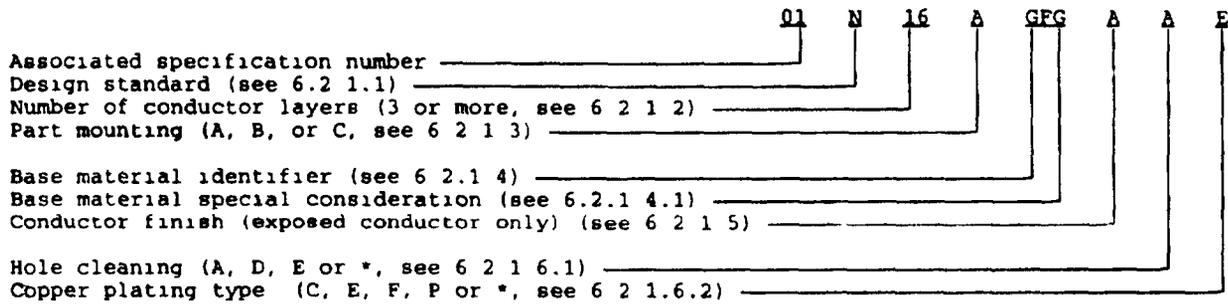
6 2 2 6 1 Hole preparation for plating A single letter indicating what type of pre-plating hole processing is to be performed The type of hole preparation to be used is identified by a single letter as follows

- A - Any hole preparation technique permitted
- D - Desmear
- E - Etchback (chemical or plasma)
- \* - As specified in the printed board procurement documentation (see 3 1)

6 2 2 6 2 Copper plating The type of plated copper is identified by a single letter as follows

- C - Electrodeposited acid copper
- P - Electrodeposited pyrophosphate copper
- E - Electrodeposited acid or pyrophosphate copper (C or P)
- F - Full-additive copper (electroless)
- \* - As specified in the printed board procurement documentation (see 3 1)

6.2.3 Optional description The description of printed wiring boards found in the printed board procurement documentation may be in the following form



6.3 Equivalent methods The following methods of determining the cleanliness of printed wiring boards have been shown to be equivalent to the resistivity of the solvent extract method

- a The Kenco Alloy and Chemical Company, Incorporated, "Omega Meter™, Model 200 "
- b Alpha Metals Incorporated, "Ionograph™ "
- c Zero Systems, Incorporated, "Zero Ion™, Model ZI-100 "
- d Westek, "ICOM 5000™ "

Table III lists the equivalence factors for these methods in terms of microgram equivalents of sodium chloride per unit area

TABLE III Equivalence factors.

Method	Equivalence factors	Equivalents of sodium chloride		Related IPC-TM-650 test method
		Micrograms per square inch	Micrograms per square cm	
Resistivity of solvent extract	1.00	10.06	1.56	2.3.5
Omega meter™	1.39	14.00	2.20	2.3.26
Ionograph™	2.01	20.00	3.10	2.3.26.1
Zero Ion™	3.68	37.00	5.80	N/A
ICOM 5000™	2.20	22.00	3.40	N/A

6.4 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 base material types GB, 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 and MIL-PRF-55110

6.5 Summary of tests A summary of all tests and inspection to be performed for inspection of product for delivery are detailed in table IV

TABLE IV Summary of inspection of product for delivery

Inspection	Requirement paragraph	Method paragraph	Test specimen 1/				Sample plan 2/
			PWB	THM	SMT	MIX	
Subgroup 1 (Panel acceptance)							
Thermal stress	3 7 6 2	4 6 6.2		B	B	B	2 PER PANEL 2/
Microsection	3 6	4 6 2		B	B	B	
Annular ring, internal	3 6 1	4 6 2					
Conductor finish thickness	3 6 2	4 6 2					
Conductor thickness	3 6 3	4 6 2					
Hole wall plating	3 6 4	4 6 2					
Copper plating thickness	3 6 4 1	4 6 2					
Copper plating voids	3 6 4 1 1	4 6 2					
Plating defects	3 6 4 2	4 6 2					
Wicking	3 6 4 3	4 6 2					
Metallic cracks	3 6 5	4 6 2					
Dielectric layer thickness	3 6 6	4 6.2					
Etchback	3 6 7	4 6 2					
Smear removal	3 6 8	4 6 2					
Conductive interfaces	3 6 9	4 6 2					
Laminate voids	3 6 10	4 6 2					
Lifted lands	3 6 11	4 6 2					
Subgroup 2 (100% tests)							
Continuity	3 7 5 1	4 6 5 1	X				100 percent 4/
Insulation (circuit shorts)	3 7.5.2	4 6 5 2	X				100 percent 4/
Subgroup 3a (Sample tests)							
Acceptability 5/ 6/	3 7 1	4 6 1	X				Plan BH
Design	3 3	4 6 1	X				Plan BH
Material	3 4	4 6 1	X				Plan BH
Visual and dimensional	3 5	4 6 1	X				Plan BH
Base material	3 5 1	4 6 1	X				Plan BH
Edges of base material	3 5 1 1	4 6 1	X				Plan BH
Surface imperfections	3 5 1 2	4 6 1	X				Plan BH
Subsurface imperfections	3 5 1 3	4 6 1	X				Plan BH
Conductor pattern	3 5 2	4 6 1	X				Plan BH
Annular ring, external	3 5 2 1	4 6 1	X				Plan BH
Bonding of conductor	3 5 2 2	4 6 1	X				Plan BH
Conductor imperfection	3 5 2 3	4 6 1	X				Plan BH
Conductor finish	3 5 2 4	4 6 1	X				Plan BH
Coverage	3 5 2 4 1	4 6 1	X				Plan BH
Whiskers	3 5 2 4 2	4 6 1	X				Plan BH
Conductor spacing	3 5 2 5	4 6 1	X				Plan BH
Conductor width	3 5 2 6	4 6 1	X				Plan BH
Dimensions	3 5 3	4 6 1	X				Plan BH
Hole pattern accuracy	3 5 4	4 6 1	X				Plan BH
Lifted lands	3 5 5	4 6 1	X				Plan BH
Solder resist	3 5 6	4 6 1	X				Plan BH
Coverage	3 5 6 1	4 6 1	X				Plan BH
Discoloration	3 5 6 2	4 6 1	X				Plan BH
Registration	3 5 6 3	4 6 1	X				Plan BH
Thickness	3 5 6 4	4 6 1	X				Plan BH
Marking	3 8	4 6 1	X				Plan BH
Workmanship	3 9	4 6 1	X				Plan BH

See footnotes at the end of table

TABLE IV Summary of inspection of product for delivery - Continued

Inspection	Requirement paragraph	Method paragraph	Test specimen 1/				Sample plan 2/
			PWB	THM	SMT	MIX	
Subgroup 3b (Sample tests)							
Chemical Cleanliness 3/	3 7 3 1 1	4 6 3 1	X				Plan *N
Subgroup 3c (Sample tests)							
Physical							
Adhesion, marking	3 7 4 1	4 6 4 1	X	g/ C	g/ C	g/ C	g/ g/
Adhesion, plating 7/	3 7 4 2	4 6 4 2	X	C	C	C	g/
Adhesion, solder resist	3 7 4.3	4 6 4 3	X	G	G 10/	G 10/	g/
Bow and twist	3 7 4 4	4 6 4 4	X				Plan BH
Solderability	3 7 4 6	4 6 4 6					Plan TJ
Hole	3 7 4 6 1	4 6 4 6		A or S		A or S	Plan TJ
Surface	3 7 4 6 2	4 6 4 6			C or M	C or M	Plan TJ

- 1/ Test coupons are in accordance with IPC-D-275 PWB is a production board, THM is a through-hole mount (see 6 2 2 4) PWB test coupon, SMT is a surface mount (see 6 2 2 4) PWB test coupon, MIX is a Mixed mounting (see 6 2 2 4) PWB test coupon
- 2/ See MIL-PRF-31032 for C = 0 sampling plans
- 3/ PDA is 32 percent
- 4/ PDA is 50 percent
- 5/ 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) are to be inspected on both the internal layers containing conductors prior to lamination and the completed printed wiring board
- 6/ Surface imperfections (3 5 1 2) and subsurface imperfections (3 5 1 3) are to be inspected prior to solder resist application
- 7/ Inspection is to be performed prior to solder resist application. Additional inspections on completed printed wiring boards may be specified
- 8/ See 4 6 4 1
- 9/ Test coupon (sample plan TJ) or production printed wiring board (sample plan BH), manufacturer option
- 10/ Test coupon T is to be used when production printed wiring boards have tented via holes

## CONCLUDING MATERIAL

Custodians  
 Army - ER  
 Navy - EC  
 Air Force - 85

Preparing activity  
 DLA - ES  
 (Project 5998-0062-01)

Review activities  
 Army - MI  
 Navy - MC  
 Air Force - 99