METRIC

MIL-PRF-31032/4
31 December 1999

PERFORMANCE SPECIFICATION

PRINTED WIRING BOARD, RIGID-FLEX OR FLEXIBLE, MULTILAYER, WITH PLATED HOLES, WITH OR WITHOUT STIFFENERS, 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 performance requirements for multilayered (three or more conductor layers) rigid-flex or flexible (with or without stiffeners) printed wiring boards with plated holes that will use soldering for component/part mounting (see 6.1.1).

1.2 Classification. Printed wiring boards covered by this specification are of the following types and usage classes.

1.2.1 Types. The printed wiring boards covered by this specification are of the following types, as specified (see 6.2e).

Type 3 - Multilayer flexible printed board.

Type 4 - Multilayer rigid-flex printed board.

1.2.2 Usage. The following usage classes describe the possible usage/application of the printed wiring boards (see 6.2f).

Class A - The flexible printed wiring board is capable of withstanding flexing during installation.

Class B - Portions of the flexible printed wiring board are capable of withstanding continuous flexing for a number of cycles specified in the printed board procurement documentation (see 6.2.1c).

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 requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

AMSC N/A FSC 5998

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these document are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available 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 which are indicated as 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 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, 100 Barr Harbor Drive, West Coshohocken, PA 19428-2959.)

INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

J-STD-003	-	Solderability Tests for Printed Boards.
IPC-2221	-	Generic Standard for Printed Board Design.
IPC-2223	-	Design Standard for Flexible Printed Boards.
IPC-TM-650	-	Test Methods Manual.

(Application for copies should be addressed to the Association Connecting Electronics Industries, 2215 Sanders Road, Suite 250, 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 performance requirements as specified herein, and the material, design and construction details 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 and 6.3).

3.3 Design (see 3.1 and 6.2c). Printed wiring boards shall be of the design as 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 as follows:

a. Overall printed wiring board design baseline shall be in accordance with IPC-2223.

b. Test coupon design, quantity, placement and usage shall be in accordance with IPC-2221. Test coupons shall reflect worst case design conditions of the printed board(s) they represent.

3.4 Printed board materials. All printed board materials used in the construction of compliant flexible printed wiring boards shall comply with the applicable specifications referenced in the printed board procurement documentation. If printed board materials needed in the production of printed wiring boards are not specified, then it is the manufacturer's responsibility to use printed board 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 External visual and dimensional requirements. The finished production printed wiring boards, supporting test coupons, or qualification test specimens (hereafter referred to as printed wiring board test specimens) shall conform to the requirements specified in 3.5.1 through 3.5.9, as applicable.

3.5.1 Base material.

3.5.1.1 Edges of flexible sections. The trimmed edge of finished printed wiring boards shall be free of defects such as burrs, delaminations, nicks, or tears in excess of those allowed in 3.5.1.2 and 3.5.1.3. Following the solderability or thermal stress tests, discolorations or resin recession at finished or trimmed edges of the flexible sections shall be acceptable providing the discoloration or resin recession dimension does not reduce the edge spacing below the specified requirements.

3.5.1.2 Edges of rigid sections. Burrs, chips, delaminations, haloing, nicks and other penetrations along the rigid base material edges of finished printed wiring boards shall be acceptable provided the defect does not reduce the edge spacing by more than 50 percent.

3.5.1.3 Surface imperfections. Surface imperfections (such as cuts, dents, pits or scratches) shall be acceptable providing the dielectric spacing between the imperfection and conductors is not reduced below the specified minimum conductor spacing requirements.

3.5.1.4 Subsurface imperfections. Subsurface imperfections (such as adhesive voids, blistering, delamination, foreign inclusions, and so forth) shall be acceptable providing the imperfection meets the following:

a. The imperfections do not bridge more than 25 percent of the distance between access holes, conductors, 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 (.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 wiring board area, maximum.

e. Following the solderability or thermal stress test, discoloration or resin recession shall be acceptable at access hole edges provided they meet the criteria of 3.5.1.1.

3.5.2 Conductor pattern.

3.5.2.1 Annular ring, external. The external annular ring shall be as specified.

3.5.2.1.1 Solderable components lands. Unless otherwise specified, the annular ring may have a 20 percent reduction of the specified minimum external annular ring due to defects such as pits, dents, nicks, pinholes, and cover lay (see 3.5.3.1) or stiffener (see 3.5.9) access hole misregistration. No more than 20 percent of the annular ring circumference (72 degrees) may be affected.

3.5.2.1.2 Adhesive on lands of plated-through holes. Unless otherwise specified, the minimum external annular ring for solderable plated-through holes shall not be reduced by more than 10 percent due to adhesives extruded onto lands.

3.5.2.1.3 Adhesive on lands of unsupported holes. Unless otherwise specified, the minimum external annular ring for solderable unsupported holes shall not be reduced by more than 20 percent due to adhesives extruded onto lands.

3.5.2.2 Bonding of conductor to base material. There shall be no peeling or lifting of any conductor from the base material. Note: An allowance for some lifting of terminal pads is allowed following the thermal stress test (see 3.6.11).

3.5.2.3 Conductor finish (plating or coating). The conductor finish shall be as specified.

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

3.5.2.3.2 Thickness (non destructive). The conductor finish thickness shall be as specified.

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

3.5.2.4 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 the conductor length, whichever is less.

3.5.2.5 Conductor spacing. The conductor spacing shall be as specified.

3.5.2.6 Conductor thickness (external)(non destructive). The conductor thickness shall be as specified. Unless otherwise specified (when applicable), the minimum final metal foil thickness shall not be reduced by more than 10 percent for deposited metal foil types and 5 percent for wrought or rolled metal foil types, from the nominal starting metal foil thickness as converted from the area weight of the foil.

3.5.2.7 Conductor width. The conductor width shall be as specified (see 3.5.2.4).

3.5.3 Cover lay.

3.5.3.1 Access hole registration. The cover lay registration shall be such that the size or diameter of the access hole shall not reduce the component land area or minimum annular ring below the limits specified (see 3.5.2.1). Misregistration of the cover lay shall not expose adjacent isolated conductors or lands.

3.5.3.2 Delamination. There shall be no cover lay delamination along the outer edges of the cover lay. Cover lay delamination shall be acceptable providing the following conditions are met:

a. At random locations away from conductors if each delamination is no larger than 6.45 square mm (.010 square inch) (approximately 1.27 mm (.050 inch) diameter), and is not within 1.0 mm (.040 inch) of the printed wiring board edge or an access hole edge. The total number of the above delaminations shall not exceed three in any 645 square mm (1.0 square inch) of cover lay surface area.

b. Along conductor edges, the total delamination does not exceed either 0.051 mm (.02 inch) in width or 20 percent of the spacing between adjacent conductors, whichever is smaller.

3.5.3.2.1 After folding flexibility testing. After exposure to the folding flexibility test (see 3.7.4.6 and 4.6.4.6), there shall be no propagation of any cover lay delamination in the continuous flex area.

3.5.3.3 Solder wicking. Wicking of solder under the cover lay shall be acceptable provided the conductor spacing requirements are met.

3.5.3.4 Wrinkles or creases. Wrinkles or creases in the cover lay shall be acceptable provided the requirements of 3.5.3.2 are met.

3.5.4 Dimensions. The finished printed wiring board shall meet the dimensional (such as cutouts, overall thickness, periphery, etc.) requirements specified.

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

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

3.5.7 Layer-to-layer registration. The layer-to-layer pattern misregistration shall not exceed the specified limits. For cover lay access hole registration, see 3.5.3.1. For stiffeners access hole registration, see 3.5.9.

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

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

a. 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.

b. The exposed conductor shall not be bare copper.

c. The solder resist imperfection does not expose tented via holes.

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

3.5.8.3 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 shall 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 (intended for assembly testing) shall be free of solder resist unless a partial coverage allowance is specified.

3.5.8.4 Thickness. Solder resist thickness shall be as specified.

3.5.9 Stiffeners (type 3, see 6.6). The design, placement and acceptability requirements for stiffeners shall be as specified.

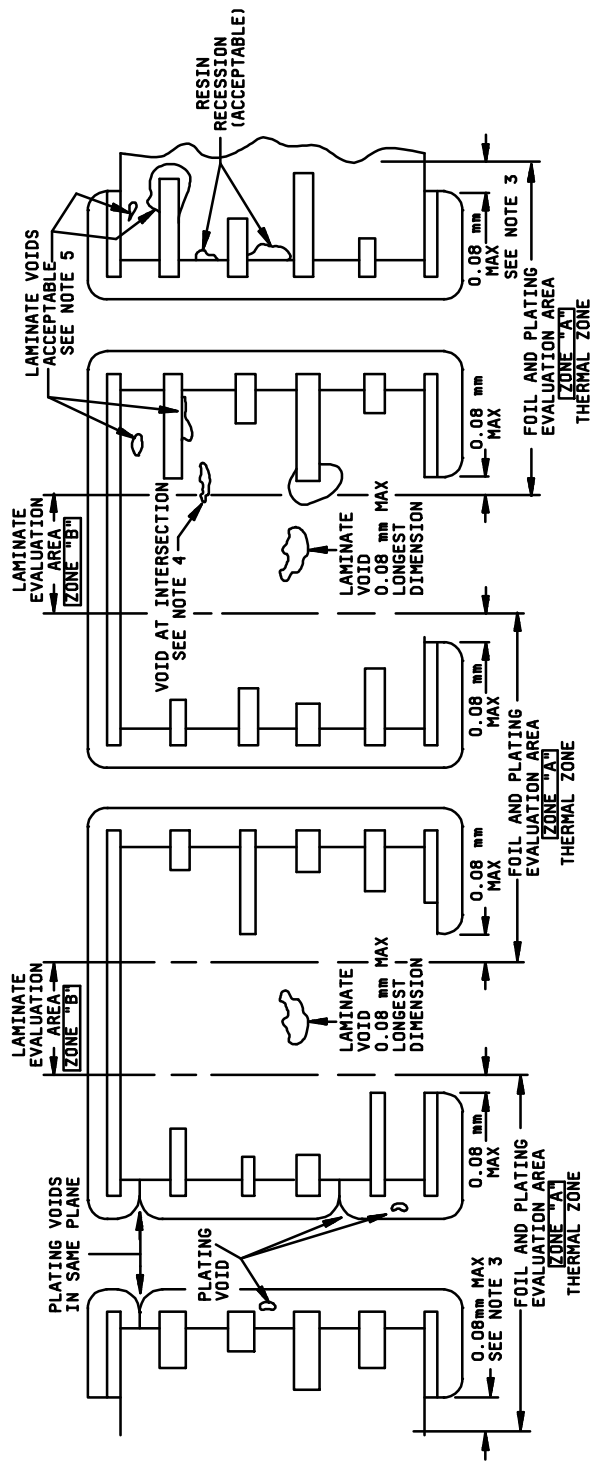
3.5.9.1 Stiffener access hole registration. Stiffener access hole registration shall be such that the size or diameter of the access hole shall not reduce the component land area or minimum annular ring below the limits specified (see 3.5.2.1.1).

3.6 Internal visual and dimensional requirements (for designs with plated holes only). Printed wiring board test specimens shall meet 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 (plating or coating) thickness (destructive). The conductor finish thickness shall be as specified.

3.6.3 Conductor thickness (internal and external)(destructive). The conductor thickness on printed wiring boards shall be as specified. If only a starting metal foil weight is specified, the minimum final conductor thickness (metal foil or metal foil and plating, as applicable) shall not be reduced by more than 10 percent for deposited metal foil types and 5 percent for wrought or rolled metal foil types, from the nominal starting metal foil thickness as converted from the area weight of the foil.



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.

3.6.4 Hole plating (when applicable).

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 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.

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 features. Copper plating features, such as 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. Plating folds are allowed when closed.

3.6.5 Metallic cracks. There shall be no cracks in the platings or coatings. For lands plated with copper, cracks are permissible in the underlying copper foil provided they do not extend or propagate into the plating or coating.

3.6.6 Dielectric thickness (layer-to-layer separation). The minimum dielectric thickness for printed wiring boards shall be as specified.

3.6.7 Etchback (when specified, see 3.1). When specified, printed wiring 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, positive etchback shall be 0.005 mm (.0002 inch) minimum and 0.076 mm (.003 inch) maximum when measured from the end of the internal conductor contact protrusion area to the base material with a preferred depth of 0.015 mm (.0006 inch).

3.6.8 Smear removal. When etchback (positive) 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 metal. The interface between platings and coating (electroless copper, direct metallization copper and non-electroless copper substitutes, etc., and electrolytic copper, whether panel or pattern plated), shall also be considered a conductive interface.

3.6.10 Laminate and adhesive 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. Adhesive voids (when applicable) in the flexible metal clad base material no greater than 0.5 mm (.020 inch) or 25 percent of conductor spacing, whichever is less shall be acceptable. After undergoing rework simulation (see 3.7.4.7), 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. The maximum allowed lifted land distance from the base material surface to the outer lower edge of the land shall be the thickness (height of metal foil and plating, when applicable) of the terminal area or land.

3.7 Inspection requirements. Unless otherwise specified by the Technical Review Board (TRB), the performance requirements specified in 3.7.1 through 3.7.6 shall be verified by the test methods detailed in 4.6. Test optimization in accordance with MIL-PRF-31032 may be used, but printed wiring boards shall meet all of the performance requirements prescribed in the printed board procurement documentation 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 conform to the acceptance requirements specified in 3.3 (design), 3.4 (material), 3.5 (visual and dimensional), 3.8 (marking), and 3.9 (workmanship), inclusive.

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 board (when specified, see 3.1 see 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 4.6.3.2.1, the elongation shall be 6 percent minimum.

3.7.3.2.2 Tensile strength. When copper plating is tested in accordance with 4.6.3.2.2, 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 (Type 4 and designs with stiffener and bow and twist limits)(see 6.2.1b). 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 Flexibility endurance. When tested as specified in 4.6.4.5, the printed wiring board test specimen shall be capable of withstanding the specified conditions of 3.7.4.5.1 or 3.7.4.5.2, as applicable, without any evidence of damage, degradation or rejectable delamination. After the test, the requirements specified in 3.7.5.1 and 3.7.5.2 shall be met.

3.7.4.5.1 Qualification and periodic testing. A single sided (type 1) printed wiring board test specimen shall be capable of withstanding 100,000 cycles.

3.7.4.5.2 Acquiring activity specified (see 3.1.1 and 6.2.1c). The number of flexing cycles, flexing rate, and points of application of the flexing shall be specified.

3.7.4.6 Folding flexibility. When tested as specified in 4.6.4.6, printed wiring board test specimen shall be capable of withstanding the specified conditions of 3.7.4.6.1 or 3.7.4.6.2, as applicable, without any evidence of damage, degradation or rejectable delamination. After the test, the requirements specified in 3.5.3, 3.7.5.1, and 3.7.5.2 shall be met.

3.7.4.6.1 Qualification and periodic testing. The baseline parameters for qualification and periodic testing shall be as follows:

a. Direction of bend: Both directions (sides).

b. Degree of bend: 180 degrees.

c. Point of application: Center of test specimen.

d. Number of fold cycles: 25.

3.7.4.6.2 Acquiring activity specified (see 3.1.1 and 6.2.1d). The number of flexing cycles, flexing rate, and points of application of the flexing shall be specified.

3.7.4.7 Rework simulation. After undergoing the test specified in 4.6.4.7, the printed wiring board test specimens shall be microsectioned and inspected in accordance with 4.6.2 and conform to the requirements specified in 3.6.

3.7.4.8 Solderability (see 6.2.1e).

3.7.4.8.1 Hole solderability. After undergoing the test specified in 4.6.4.8, the printed wiring board test specimen shall conform to the class 3 acceptance criteria specified in J-STD-003.

3.7.4.8.2 Surface solderability. After undergoing the test specified in 4.6.4.8, 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 (see 3.1), 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. When tested as specified in 4.6.5.2, the resistance between mutually isolated conductors shall be greater than 100 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 or delamination in excess of that allowed in 3.5.1, 3.5.2, and 3.5.3.

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 4.6.1 and shall meet the requirements of 3.5.1, 3.5.2.2, 3.5.2.3, and 3.5.3. The test specimen shall then 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 final resistance shall be within 10 percent of the initial measurement.

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).

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

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

4.3.4 Qualification by similarity. A production lot may be considered qualified by similarity if the dimensional parameters are within twenty-five percent window of those currently qualified and the processing steps used are a subset of those processes used for a previous qualified technology.

4.4 Lot conformance inspection. Panels and printed wiring 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 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 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 Percent Defective Allowable (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. A sample of printed wiring boards (or test coupon that represent them) 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							
Thermal stress	3.7.6.2	4.6.6.2		B	B	B	See 4.4.1.1
Subgroup 2							
Continuity	3.7.5.1	4.6.5.1	X				100 percent 3/
Isolation resistance	3.7.5.2	4.6.5.2	X				100 percent 3/
Subgroup 3							
Acceptability 4/	3.7.1	4.6.1	X				Plan BF
Cleanliness	3.7.3.1	4.6.3.1	X				Plan BN
Subgroup 4							
Adhesion, marking	3.7.4.1	4.6.4.1	X				Plan BF
Adhesion, plating	3.7.4.2	4.6.4.2	X	C	C	C	Plan BF or TJ 5/
Adhesion, solder resist	3.7.4.3	4.6.4.3	X	G	G 6/	G 6/	Plan BF or TJ 5/
Bow and twist	3.7.4.4	4.6.4.4	X				Plan BH
Solderability							
Hole	3.7.4.8.1	4.6.4.8		A or 7/		A or 7/	Plan TJ
Surface	3.7.4.8.2	4.6.4.8			C or M	C or M	Plan TJ

1/ Unless otherwise identified, test coupons are in accordance 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/ At the acquiring activity's option for designs that will have only connectors joined to the finished assembly, electrical testing can be performed at the assembly level (see 6.2.1f).
4/ Design (3.3), conductor spacing (3.5.2.5), conductor width (3.5.2.7), conductor imperfections (3.5.2.4) and workmanship (3.9) shall be inspected on the internal layers prior to lamination.
5/ Test coupon or production printed wiring board, manufacturer's option.
6/ Test coupon T shall be used when production printed wiring boards have tented via holes.
7/ An alternative hole solderability test coupon is described in J-STD-003.

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	4.6.3.2.1	Monthly
Tensile strength	3.7.3.2.2	4.6.3.2.2	Monthly
Flexibility endurance	3.7.4.5	4.6.4.5	Annually
Folding flexibility	3.7.4.6	4.6.4.6	Monthly
Rework simulation	3.7.4.7	4.6.4.7	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 examination shall be in accordance with IPC-TM-650, method 2.1.1 or 2.1.1.2. 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 or 4.6.3.1.2 shall be used to test for ionic cleanliness.

4.6.3.1.1 Manual method. The manual method of test for printed wiring board cleanliness shall be performed in accordance with IPC-TM-650, method 2.3.25.

4.6.3.1.2 Automatic methods. The automatic methods of test for printed wiring board cleanliness shall be performed in accordance with IPC-TM-650, method 2.3.25.

4.6.3.2 Elongation and tensile strength of copper.

4.6.3.2.1 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. Samples shall be baked for 6 hours minimum at 135º C (275º F) minimum prior to plating.

4.6.3.2.2 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. Samples shall be baked for 6 hours minimum at 135º C (275º F) minimum prior to plating.

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 4.6.4.8. 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 4.6.1 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 Flexibility endurance.

4.6.4.5.1 Qualification and periodic tests. The flexibility endurance test shall be in accordance with IPC-TM-650, method 2.4.3. The following exceptions shall apply:

a. Test specimen: Test specimens shall be production designs or test coupon in accordance with IPC-TM-650, method 2.4.3.

b. Number of flex cycles: 100,000.

c. Diameter of mandrel. The diameter of the mandrel shall be twelve times the sum of the total ply thickness reduced to the nearest 2.5 mm (.098 inch).

d. Flexing rate: 0.3 seconds per cycle minimum.

e. Travel of loop (when applicable): 30 mm (1.18 inch) minimum.

4.6.4.5.2 Acquiring activity specified. The flexibility endurance test shall be in accordance with IPC-TM-650, method 2.4.3. The following details shall be specified (see 6.2.1c):

a. Number of flex cycles.

b. Diameter of mandrel.

c. Flexing rate.

d. The length of travel of loop.

4.6.4.6 Folding flexibility.

4.6.4.6.1 Qualification and periodic tests. The folding flexibility test shall be performed in accordance with 4.6.4.6.3 and figure 2.

4.6.4.6.2 Acquiring activity specified. The folding flexibility test shall be performed in accordance with 4.6.4.6.3 and figure 2. The following details shall be specified (see 6.2.1c):

a. Direction of bend (detail A in figure 2).

b. Degree of bend (detail B in figure 2).

c. Points of application (detail C in figure 2).

d. Diameter of mandrel (detail D in figure 2): The diameter of mandrel shall be twelve times overall material thickness, reduced to the nearest 2.5 mm (.098 inch).

e. Number of fold cycles.

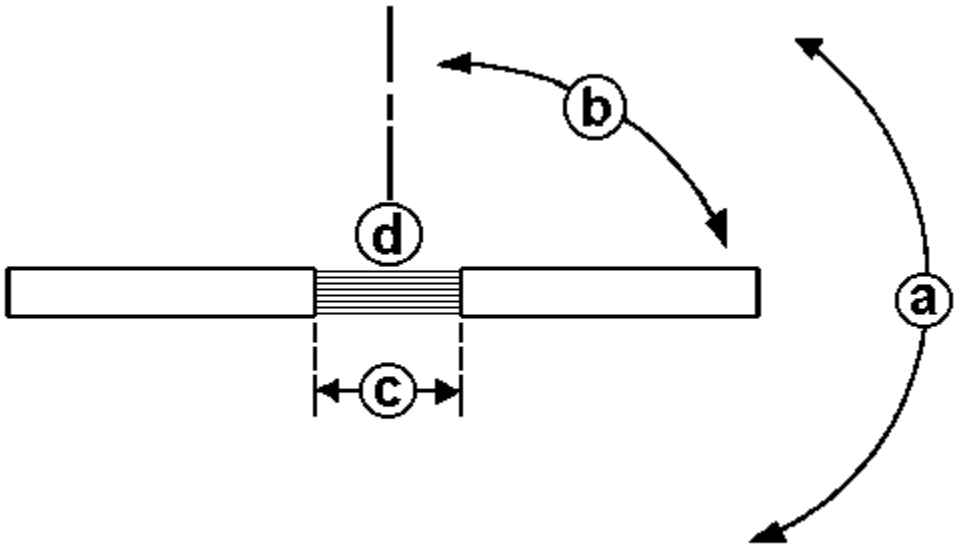


FIGURE 2. Folding flexibility test.

4.6.4.6.3 Fold cycle. A fold cycle shall be defined as taking one end of the specimen and folding it around a mandrel and then unfold back to the original starting position, traveling 180 degrees in one direction and 180 degrees in the opposite direction. A fold cycle may also be defined as folding (using opposite ends) the ends toward each other (fold the same direction) and then unfold back to the original starting position, with each end traveling 90 degrees in one direction and 90 degrees in the opposite direction. The specified number of fold cycles shall be performed with the mandrel placed in contact with the specimen on one side and then again with the mandrel placed in contact with the specimen on the opposite side (C).

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

4.6.4.8 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. The test voltage shall be the minimum rated voltage for the printed wiring board.

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, test condition A.

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 -65º C and +125º C for all flexible base materials and cover lay combinations.

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 performance characteristics of multilayer (3 or more conductor layers) flexible and rigid-flex printed wiring boards with or without plated holes, that will use soldering for component/part mounting. Other flex or rigid-flex printed board technology types (such as single or double sided designs) can be verified to the requirements contained in this document, however, the performance parameters and baseline verification methods of other associated specifications may be more appropriate. The supplement for MIL-PRF-31032 contains a list all of applicable and current associated specifications at the time of its date.

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 2.2).

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 type classification (type 3 or 4, see 1.2.1 and 3.1).

f. The printed wiring board usage classification (class A or B, see 1.2.2 and 3.1).

g. 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.

h. Requirements for certificate of compliance, if applicable.

i. Requirements for notification of change of product or process to the contracting activity in addition to notification to the qualifying activity, if applicable.

j. Levels of preservation and packing required.

k. If special or additional identification marking is required (see 3.8).

l. 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. Additional or special cleanliness is required (see 3.7.3.1 and 6.5).

b. Additional or special requirements for bow and twist (see 3.7.4.4).

c. Special requirements for flex endurance (see 3.7.4.5).

d. Special requirements for folding flexibility (see 3.7.4.6).

e. The durability of coating rating (accelerated aging for solderability testing) if other than category 2 (see J-STD-003, 3.7.4.8).

f. Special requirements for electrical testing at the assembly level.

g. Disposition of lot conformance inspection sample units.

h. Requirements for failure analysis, corrective action and reporting of results.

i. Any other additional special requirements.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturer's List QML-31032 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, DSCC-VQE, 3990 East Broad Street, Columbus, Ohio 43216-5000.

6.4 Replacement information. This specification includes a majority of the performance requirements of previous revisions of MIL-P-50884 for types 3 and 4 printed wiring boards. Printed wiring boards conforming to this associated specification would be comparable to printed wiring boards conforming to MIL-P-50884.

6.5 Notes regarding optional cleanliness verification testing. This optional verification test is not listed in Table I, Lot Conformance Inspection. If verification is required, the acquiring activity should specify acceptability requirements and test specimen sampling frequency.

6.6 Stiffener adhesion test and requirement. This document does not include the stiffener adhesion test or requirement contained in MIL-P-50884. All stiffeners are viewed as a mechanical support and total bonding of the stiffener to the printed wiring board is not required for compliance with this document.

6.7 Test coupons not detailed in IPC-2221. IPC-2221 currently does not detail the test coupons needed to perform the folding flexibility or flex endurance test. These test coupons are detailed in the individual IPC-TM-650 test method referenced for the test.

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

Review activities
Army – MI
Navy – CG

Preparing activity:
DLA – CC

(Project 5998-0085)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-31032/4	2. DOCUMENT DATE 31 December 1999

3. **DOCUMENT TITLE**
PRINTED WIRING BOARD, RIGID-FLEX OR FLEXIBLE, MULTILAYER, WITH PLATED HOLES, WITH OR WITHOUT STIFFENERS, FOR SOLDERED PART MOUNTING

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) COMMERCIAL DSN FAX EMAIL	7. DATE SUBMITTED

8. PREPARING ACTIVITY

a. Point of Contact David Corbett	b. TELEPHONE Commercial: 614-692-0526 DSN: 850-0526 FAX: 614-692-6939 EMAIL: david_corbett@dscc.dla.mil
c. ADDRESS Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, Columbus, OH 43213-1199	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888