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SUPERSEDING
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MILITARY SPECIFICATION

PRINTED WIRING ASSEMBLIES

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

1. SCOPE

1.1 Scope. This specification covers conformally coated printed wiring assemblies (circuit-card assemblies) consisting of rigid printed wiring boards on which separately manufactured parts have been added (see 6.2).

1.2 Classification.

1.2.1 Types. Printed wiring assemblies shall be of the types shown in table I, as specified (see 6.2).

TABLE I. Types.

Type designator	Board type
1	Single-sided board
2	Double-sided board
3	Multilayer board

2. APPLICABLE DOCUMENTS

2.1 Government documents. Unless otherwise specified, the following specifications and standards, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-S-571	-	Solder; Tin Alloy; Lead-Tin Alloy; and Lead Alloy.
QQ-S-781	-	Strapping, Steel, Flat and Seals.
QQ-W-343	-	Wire, Electrical (Uninsulated).
PPP-B-566	-	Boxes, Folding, Paperboard.
PPP-B-585	-	Boxes, Wood, Wirebound.
PPP-B-601	-	Boxes, Wood, Cleated-Plywood.
PPP-B-621	-	Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636	-	Boxes, Shipping, Fiberboard.
PPP-B-676	-	Boxes, Setup.
PPP-C-1842	-	Cushioning Material, Plastic, Open Cell (For Packaging Applications).
PPP-T-60	-	Tape, Packaging, Waterproof.
PPP-T-76	-	Tape, Pressure-Sensitive Adhesive Paper, (For Carton Sealing).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Electronic Systems Command, ATTN: ELEX 8111, Washington, DC 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 5999

MILITARY

MIL-P-116 - Preservation, Methods of.
MIL-P-13949 - Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), General Specification for.
MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base).
MIL-I-46058 - Insulating Compound, Electrical (For Coating Printed Circuit Assemblies).
MIL-P-55110 - Printed Wiring Boards.
MIL-B-81705 - Barrier Materials, Flexible, Electrostatic-Free, Heat Sealable.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-275 - Printed Wiring for Electronic Equipment.
MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of.
MIL-STD-810 - Environmental Test Methods.
MIL-STD-1188 - Commercial Packaging of Supplies and Equipment.
MIL-STD-45662 - Calibration Systems Requirements.

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein.

INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS

ANSI/IPC-T-50 - Terms and Definitions.
IPC-S-815 - General Requirements for Soldering of Electrical Connections and Printed Wiring Assemblies.

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 3451 Church Rd., Evanston, Illinois 60203.)

BUREAU OF MEDICINE AND SURGERY (BUMED)

BUMED INST 6270.3 - Personnel Exposure Limit Values for Health Hazardous Air Contaminants.

(Application for copies should be addressed to the Chief, Bureau of Medicine and Surgery, Department of the Navy, Washington, DC 20372.)

3. REQUIREMENTS

3.1 General requirements. Printed wiring assemblies furnished under this specification shall be a product which meets the requirements of this specification and the applicable assembly drawing (see 6.1 and 6.2). The design features of the printed wiring assemblies shall be in accordance with MIL-STD-275 and the approved assembly drawing.

3.1.1 Conflict. In the event of any conflict between the approved assembly drawing and the requirements of this specification, the provisions of the assembly drawing(s) shall govern. Changes to the approved assembly drawing(s) shall be processed in accordance with the requirements of MIL-STD-275.

3.2 First article. Printed wiring assemblies furnished under this specification shall be products which have passed the first article inspection specified in 4.4. Alternatives provided in this specification do not constitute authority to produce production units using different materials or processes other than those used on the first article sample.

3.3 Terms and definitions. Terms and definitions shall be in accordance with the Appendix, paragraph 30. In the event of conflict, ANSI/IPC-T-50 shall govern.

3.4 Materials. Materials furnished as part of the printed wiring assembly shall be as specified herein and in the applicable assembly drawing. Such materials shall be non-toxic (threshold limit values for toxicity per BUMED Instruction 6270.3) and shall meet the certification requirements of 4.3. When data is not available to support such certification, it will be necessary to generate data showing compliance with these requirements. For materials not listed in BUMED Instruction 6270.3, it may be necessary to establish acceptable limits of toxicity. The responsibility for inspection of material quality shall be as specified in 4.1.

3.4.1 Materials and processes compatibility. It shall be the responsibility of the manufacturer to select those processes and materials which are compatible with one another and which best suit the end product desired by the contract.

3.4.2 Printed wiring boards. Printed wiring assemblies shall use rigid printed wiring boards in accordance with MIL-P-55110 and MIL-STD-275.

3.4.3 Component leads and wires. Incoming inspection should be performed on all component leads and wires per the appropriate component/wire specification(s). Prior to component assembly all component leads and wires shall show evidence of good solderability in accordance with 4.3.1 or shall be tinned. Component leads and wires shall be appropriately stored prior to assembly. Leads and wires that were tested for solderability shall be assembled within six months of testing; leads and wires that have been tinned shall be assembled within one year of tinning. Component leads and wires exceeding the time requirements shown above shall be retested or retinned prior to assembly.

3.4.3.1 Component parts and wires. Component parts and wires shall be as specified on the approved assembly drawing(s) and associated parts list(s).

3.4.3.2 Gold-plated leads and wires. All gold-plated leads and wires that are hand soldered or planar mounted shall be tinned.

3.4.4 Solder. The solder used shall be in accordance with composition Sn 60, Sn 62, or Sn 63 of QQ-S-571. For wave or dip soldering, use bar solder, form B. For hand soldering, use solder wire form W, either solid metal, type S, or with a core of flux of either type R, RMA, or RA of QQ-S-571, with the exception that RA flux shall not be used on stranded wire. (With special contract approval type, RA flux may be used on Army ERADCOM, CORADCOM, and AVRADCOM contracts).

3.4.5 Soldering flux. Soldering flux shall be a liquid flux conforming to MIL-F-14256, type R, RMA, or RA, with the exception that RA flux shall not be used on stranded wire. (With special contract approval, type RA flux may be used on Army ERADCOM, CORADCOM, and AVRADCOM contracts.)

3.4.6 Conformal coating. Conformal coating material shall be as specified on the approved assembly drawing and shall be in accordance with MIL-I-46058.

3.4.7 Buffer material (see 3.6.8). The buffer material shall be a thin, pliant material such as polyvinylidene fluoride, polyethlene terephthalate, or silicone rubber, and be nonreactive with the conformal coating material and all parts to which it comes in contact. The buffer material shall be fungus and flame resistant, and clear or transparent so markings on the components are visible (see 3.8.9 and 3.9.).

3.5 Design principles and production criteria. Part mounting and attachment shall be in accordance with this specification, and the approved assembly drawing (see 3.1), or other documents of the assembly manufacturer referenced on the approved assembly drawing. The requirements of 3.5.1 through 3.5.2.4 shall apply to the mounting of parts on the printed wiring assembly.

3.5.1 Part mounting. Each part shall be mounted in the location specified on the approved assembly drawing. All parts shall be correctly located, oriented, mounted, and attached. All parts shall be correctly soldered (see 3.5.2 and 3.5.3).

3.5.1.1 Location. Parts shall be mounted so as to avoid the occurrence of moisture traps.

3.5.1.2 Conductive areas. The part shall be mounted so that subsequent conformal coating will cover the conductive area under the part except where thermal dissipation or electrical conduction is required. When conformal coating will not cover conductive areas under the part, the conductive areas shall be insulated and protected against moisture entrapment by applying, and curing a resin coating, laminating low flow prepreg material in accordance with MIL-P-13949, or by a solder mask coating over the area prior to mounting of the parts.

3.5.1.3 Spacing. Parts shall be mounted and spaced so that any part can be removed from the board without having to remove any other part, unless otherwise specified on the approved assembly drawing.

3.5.1.3.1 Electrical spacing. The minimum spacing between component leads, wires, conductor patterns, and other conductive material (such as conductive markings or mounted hardware) shall be in accordance with table II.

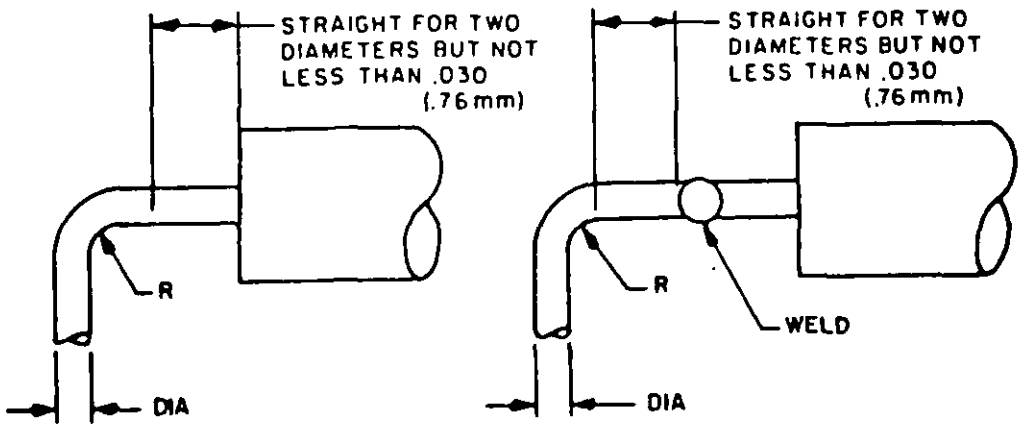
TABLE II. Electrical spacing.

Voltage between conductors (dc or ac peak)	Minimum spacing
Volts	
0-15	0.005 inch(0.13 mm)
16-30	0.010 inch(0.25 mm)
31-50	0.015 inch(0.38 mm)
51-100	0.020 inch(0.51 mm)
101-300	0.030 inch(0.76 mm)
301-500	0.060 inch(1.52 mm)
Greater than 500	0.00012 inch(.00305 mm) (per volt)

3.5.1.4 Alinement of part leads. Axial part leads shall coincide to the centerline through their respective land areas whenever possible. The part lead may overhang the land area only if the resultant electrical spacing between adjacent conductors meets the requirements specified in table II.

3.5.1.5 Stress relief bends. Parts shall be mounted or provided with stress relief bends in such a manner that the leads cannot overstress the part-lead interface when subjected to the conditions of 3.8.3 through 3.8.6. The straight lead length adjacent to the component body shall be in accordance with figure 1. NOTE: For solder in the stress relief band of axial-leaded parts see 3.5.1.7.

3.5.1.6 Lead bend radius. Minimum bend radius for leads shall be in accordance with figure 1.



A. STANDARD BEND

B. WELDED BEND

Lead diameter in inches	Minimum radius (R) inch
≤.027(.69 mm) >.028(.71 mm) _ .047(1.19 mm) ≥.048(1.22 mm)	1 diameter 1.5 diameter 2 diameters

FIGURE 1. Lead bend.

3.5.1.7 Axial-leaded parts. Axial-leaded parts shall be mounted as specified on the approved assembly drawing or mounted so that a portion of the body is as close to the printed wiring board as possible. The leads shall be shaped in accordance with 3.5.1.5 and 3.5.1.6. This does not apply to parts mounted on standoff terminals (see 3.5.2.1). Solder which extends into the lead bend radius of axial-leaded parts is acceptable only into the lead bend radius on one lead of the part (the lead which is closest to the board). Solder shall not extend beyond the land (see figure 2).

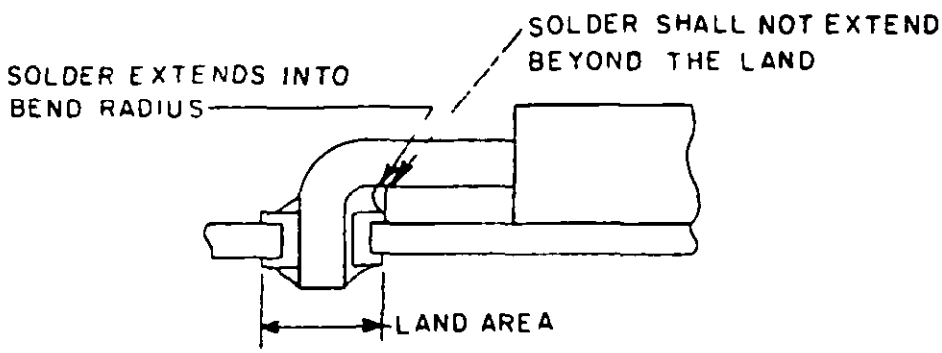


FIGURE 2. Solder in bend radius.

3.5.1.7.1 Perpendicular mounting. When specified on the approved assembly drawing, axial-leaded parts weighing less than 0.50 ounce shall be mounted perpendicular to the board. The part shall be mounted to provide a minimum of 0.015 inch between the end of the part body and the mounting surface. The end of the part is defined to include any coating meniscus, solder seal, solder or weld bead, or any other extension. The maximum vertical misalinement of the part's vertical axis shall be 15 degress in any direction from a line perpendicular to the mounting surface. The maximum allowed vertical height of the part from the board mounting surface shall be 0.55 inch (see figure 3).

FIGURE 3. Perpendicular part mounting.

3.5.1.8 Nonaxial-leaded parts. Non-axial leaded parts shall be mounted with the surface from which the lead projects (end of the part) a minimum of 0.010 inch above the board mounting surface.

3.5.1.8.1 Multiple-leaded components. Multiple-leaded components (components with three or more leads), except multiple-leaded components mounted to thermal planes or heat sinks, shall be mounted in such a manner that spacing is provided under the body of the part to facilitate cleaning.

3.5.1.9 Heat dissipating parts. All parts dissipating 1 watt or more shall be mounted as specified on the approved assembly drawing or in such a manner that the body of the part is not in direct contact with the printed wiring board unless either a clamp or thermal groundplane, or both, is used which will dissipate sufficient heat so that the maximum allowable operating temperature of the printed wiring board is not exceeded.

3.5.1.10 Jumper wires. Jumper wires shall be short as practical and shall not be applied over or under other parts. Jumper wires less than 0.5 inch in length whose path does not pass over conductive areas and does not violate the spacing requirements of 3.5.1.3.1 may be uninsulated.

3.5.1.11 Interfacial connections.

3.5.1.11.1 Clinched wires. Interfacial connections on type 2 boards may be made by the use of uninsulated solid wire in accordance with QQ-W-343, type S, coated, extending through a hole and clinched. The wire shall make contact with the conductor pattern on each side of the printed wiring assembly before soldering (see figure 4) and the end shall not extend beyond the edge of its land area or its electrically connected conductor pattern in violation of the minimum spacing requirements. Part lead wires do not qualify for interfacial connections. The top and bottom portions of the wire need not be alined in the same vertical plane.

3.5.1.11.2 Plated-through holes. Plated-through holes used for interfacial connections, internal or interlayer connections shall not be used for mounting of eyelets, standoff terminals, rivets, or other devices which put the plated-through hole in compression. Interfacial connections on type 2 boards may also be made by the use of plated-through holes. Interfacial connections on type 3 boards shall be made only by the use of plated-through holes.

3.5.2 Part attachment. Part attachment shall be in accordance with the requirements of IPC-S-815.

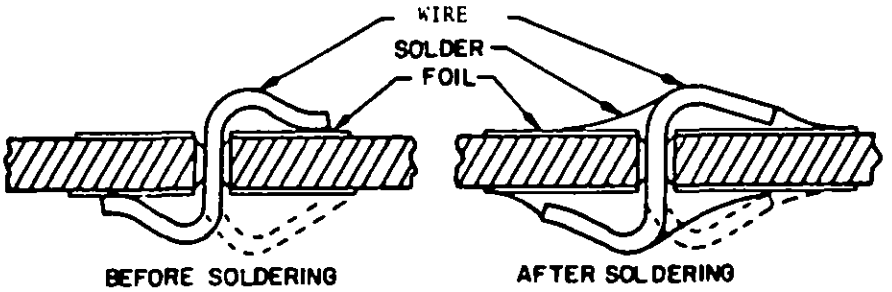


FIGURE 4. Clinched wire (interfacial connection) (direction of clinch optional) (Type 2 boards only).

3.5.2.1 Standoff terminals. Part attachment to standoff terminals shall be in accordance with the requirements of IPC-S-815.

3.5.2.2 Clinched leads. Clinched leads shall be in accordance with the requirements of IPC-S-815.

3.5.2.3 Straight-through, partially clinched or swaged leads. Straight-through, partially clinched or swaged leads shall be in accordance with the requirements of IPC-S-815.

3.5.2.4 Ribbon leads. Flat-wire ribbon leads shall be attached in accordance with IPC-S-815.

3.5.3 Soldering. Soldering shall be in accordance with IPC-S-815, class III. Solder shall not be used on surfaces specified to be free of solder. Solder and flux shall be in accordance with 3.4.4 and 3.4.5.

3.5.3.1 Metal. All metal surfaces shall be free of corrosion and contamination. All printed conductors shall be firmly bonded to the printed wiring board.

3.5.3.2 Solder plugs applicability.

3.5.3.2.1 When applicable. Solder plugs are required in:

a. All electrically functional plated-through holes with a lead.
b. 98 percent of all plated-through holes (electrically functional or not, without a lead) that are subjected to wave or dip soldering.

3.5.3.2.2 When not applicable. Solder plugs are not required in:

a. Unsupported holes with a lead.
b. Non-functional plated-through holes (hand soldered).
c. Any electrically functional plated-through hole (without a lead) not subjected to wave or dip soldering.

3.5.3.3 Post soldering cleaning. Printed wiring assemblies shall be cleaned within 1 hour after completion of soldering using solvents or combinations of solvents or other solutions which will remove polar and nonpolar contaminants (see appendix). After cleaning, printed wiring assemblies shall not be contaminated by handling or environment prior to conformal coating. After cleaning there shall be no visual evidence of flux residue or other contamination. "Other contamination" includes particles of foreign matter which may result in insulation breakdown or change in electrical characteristics or degradation of mechanical integrity (e.g., improper bonding of conformal coating). This solder cleaning requirement shall also apply after rework.

3.5.3.4 Measling and crazing. After soldering and cleaning processes have been completed, measling or crazing, or both, on the printed wiring assembly shall not bridge more than 50 percent of the distance between electrical conductors and/or not exceed 3 percent of the total printed wiring board surface area on one side. A separate measurement and determination shall be made for each side of the printed wiring assembly (see 4.8.1). If measling or crazing, or both, of any extent occurs on more than 5 percent of a printed wiring assembly lot sample examined (see 4.6.1.2.2), the lot shall be rejected and corrective action is required.

3.5.3.5 Delamination, blistering or softening. There shall be no delamination, blistering, or softening of the plastic materials.

3.6 Conformal coating. Conformally coated printed wiring assemblies furnished under this specification shall meet the requirements of this specification before and after repair (see 3.7). The coated assemblies shall have no blisters, cracking, crazing, peeling, wrinkles, mealing, or evidence of reversion or corrosion. A pin-hole or bubble and/or a combination of pinhole(s) and bubble(s) may bridge up to 50 percent of the distance between conductors, provided that the minimum dielectric spacing requirement is not violated.

3.6.1 Coating area. Printed wiring assemblies, except those using a board material of polytetrafluoroethylene shall be conformally coated with a coating material that conforms to 3.4.6. The coating shall be applied to both sides of the cleaned printed wiring assembly.

3.6.2 Adjustable components. Printed wiring assemblies having adjustable components shall not have the adjustable portion covered with coating, unless otherwise specified on the approved assembly drawing.

3.6.3 Mating surfaces. Electrical and mechanical mating surfaces, such as probe points, screw threads, bearing surfaces, etc., shall not be coated.

3.6.4 Masking. The masking material used to prevent coating in unwanted areas shall have no deleterious effects on the printed wiring assembly.

3.6.5 Compatibility. The conformal coating shall be compatible with all parts and material of the printed wiring assembly.

3.6.6 Thickness. The thickness of the conformal coating shall be as follows for the type specified, when measured on a flat unencumbered surface (see MIL-I-46058).

a. Types ER, UR, and AR: 0.003 ±0.002 inch.
b. Type SR: 0.005 ±0.003 inch.
c. Type XY: 0.0005 to 0.002 inch.

3.6.7 Electrical performance. Printed wiring assemblies shall be constructed, adequately masked, or otherwise protected in such a manner that application of conformal coating does not degrade the electrical performance of the assembly. Electrical testing shall be accomplished (see 6.1).

3.6.8 Buffer material (see 3.4.7). Buffer material shall be as required on the approved assembly drawing.

3.6.9 Surfaces to be free of coating. Surfaces specified on the approved assembly drawing to be free of conformal coating shall be suitably masked and protected from coating, coating residues, and masking residues.

3.6.10 Cleanliness (see 4.8.2). When tested in accordance with 4.8.2 and sampled in accordance with 4.5.2, printed wiring assemblies shall have no evidence of flux residues, ionic and other contaminants before applying the coating. Cleaning compounds shall have no deleterious effects on any part of the printed wiring assembly. In the case of printed wiring boards requiring permanent solder-mask, conformal or other coating, the uncoated boards shall be free of ionic contaminants or flux residue (see 6.4) prior to the application of conformal coating. Prior to the application of any coating, the Government reserves the right to require confirmation that the uncoated printed wiring assemblies were inspected for cleanliness. The cleanliness test shall be accomplished (see 6.1).

3.6.10.1 Resistivity of solvent extract (see 6.6). The test solution used to wash uncoated printed wiring assemblies shall have a resistivity not less than 2,000,000 ohm - centimeter (or equivalent) when tested in accordance with 4.8.2 as required by in-process inspection of 4.5 The equivalent test methods and factors specified in 6.6.1 may be used in lieu of the method specified in 4.8.2 Other equivalent test methods not specified in 6.6.1 may be used in lieu of 4.8.2 only when specifically approved by the government procuring activity. Such approval will be determined on the basis that the alternate method is demonstrated to have equal or better sensitivity, and employs solvents with the ability to dissolve flux residue as does the alcohol-water solution specified in 4.8.2.

3.7 Rework, Repair and Modification. Rework, repair and modification shall be accomplished as described in the following paragraphs. Assemblies reworked, repaired or modified by these methods shall be processed as normal material.

3.7.1 Rework. The rework of defective solder connections and replacement of defective components is permissible (see Appendix 30.1.11). Defective solder plugs in plated through holes which do not contain a component lead, and within the 2 percent limit of 3.5.3.2.1.b, need not be reworked. After rework, the assembly shall meet the requirements of 3.8.

3.7.2 Repairs. Standard repairs (see 30.1.12) described by appendix paragraph 50.2 and authorized by paragraph 10.2.1 may be performed within the limitations set forth. Such repairs shall be documented as specified in the appendix. Proposed methods of repair other than the standard repairs shall be submitted to the Government procuring activity for approval. Approval for such repairs are applicable only to the contract under which the approval was granted.

3.7.3 Modifications. Modifications (see 30.1.9) may be made to prototype or production assemblies in accordance with the appendix. Modifications require written authorization (see 10.2.2) of the Government procuring activity and shall be documented as specified in the appendix (see 40.4).

3.8 Printed wiring assembly performance requirements. Upon completion of final assembly, the printed wiring assemblies shall meet all visual, electrical, and all other operational requirements in accordance with the requirements of the approved assembly drawing(s) and test specifications.

3.8.1 Bow and twist. When tested as specified in 4.8.3, the maximum allowable bow and twist shall be 1.5 percent, unless otherwise specified on the approved assembly drawing.

3.8.2 Electrical parameters. When tested as specified in 4.8.4, printed wiring assemblies shall function as specified on the approved assembly drawing.

3.8.3 Vibration (when specified). When tested as specified in 4.8.5, printed wiring assemblies shall be capable of continuous operation as specified (see 3.8), and there shall be no evidence of physical damage.

3.8.4 Shock (when specified). When tested as specified in 4.8.6, printed wiring assemblies shall be capable of continuous operation as specified (see 3.8), and there shall be no evidence of physical damage.

3.8.5 Thermal shock. After testing as specified in 4.8.7, printed wiring assemblies shall be capable of operation as specified (see 3.8), and there shall be no evidence of physical damage.

3.8.6 Temperature-altitude (when specified). When tested as specified in 4.8.8, printed wiring assemblies shall be capable of continuous operation as specified (see 3.8), and there shall be no evidence of physical damage.

3.8.7 Humidity. When tested as specified in 4.8.9, there shall be no evidence of corrosion on any part of the printed wiring assembly. No crazing or measling (in excess of that allowed in 3.5.3.4), blistering, cracking, delamination, embrittlement, mealing, or softening shall become evident in the conformal coating or other constituent parts and materials used in the assembly. The electrical performance of the assembly shall not be degraded (see 3.8).

3.8.8 Salt fog (when specified). When tested as specified in 4.8.10, there shall be no evidence of corrosion of the printed wiring assemblies.

3.8.9 Fungus (when specified). When tested as specified in 4.8.11, the materials or combination of materials used in the production of printed wiring assemblies shall not serve as nutrients to fungi.

3.9 Marking. Printed wiring assemblies shall be marked as specified on the approved assembly drawing(s). All assemblies shall be serialized for traceability. The board may be marked at the discretion of the contractor for use as manufacturing aids; covering such marking by the components at assembly shall not be cause for rejection.

3.10 Workmanship. Printed wiring assemblies shall be clean and show no evidence of dirt, foreign matter, oil, fingerprints, corrosion, salts, flux residues, and contaminants. The completed printed wiring assembly shall also be free of defects as defined in 4.8.1.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities acceptable to the Government procuring activity, which are suitable for the performance of the inspection requirements specified herein. The Government procuring activity reserves the right to perform any of the inspections set forth in the specification, where such inspections are deemed necessary to assure conformance to prescribed requirements.

4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662.

4.1.2 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "General Requirements" of MIL-STD-202 and MIL-STD-810,and acceptability inspection of IPC-S-815, as applicable.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

a. Incoming component and materials inspection (see 4.3).
b. First article inspection (see 4.4).
c. In-process inspection (see 4.5).
d. Quality conformance inspection (see 4.6).

4.3 Incoming component and materials inspection. Inspection shall, as a minimum, consist of certification supported by verifying data that the components and materials listed in table III, used in fabricating the printed wiring assemblies, are in accordance with the applicable referenced documents, specifications, and requirements prior to such fabrication. Additional materials inspection shall be as specified in applicable engineering drawing(s), as specified in 3.4.3, 3.4.3.1, and 4.3.1.

4.3.1 Solderability of component leads and wires. All component leads and wires of all electronic and electrical components shall be tinned or shall be inspected in accordance with 4.3.1.1 and shall meet the solderability requirements of MIL-STD-202, test method 208 (see table III).

4.3.1.1 Sampling plan for solderability test (see 4.3.1). Lot sampling shall be in accordance with MIL-STD-105, special inspection level S-4, with an AQL of 2.5. Samples for solderability test may be selected from components that failed to meet incoming electrical testing (see 3.8).

TABLE III. Component and materials inspection.

Component and materials	Requirement paragraph	Applicable specification
Printed wiring board	3.4.2	Master drawing
Component lead and wire solderability	3.4.3	MIL-STD-202, Test method 208
Components parts and wire	3.4.3.1	As specified on assembly drawings
Solder	3.4.4	QQ-S-571
Soldering flux	3.4.5	MIL-F-14256
Conformal coating	3.4.6	Assembly drawing MIL-I-46058
Buffer material	3.4.7	Assembly drawing

4.4 First article inspection. First article inspection shall be performed by the contractor, at a location acceptable to the government procuring activity. First article inspection shall be performed on sample printed wiring assemblies which have been produced with material, equipment, processes, and procedures which shall be used in production. Production is defined as one or more printed wiring assemblies delivered on a contract. First article inspection is divided into two categories, Design and Type, as defined in paragraph 4.4.1.1 and 4.4.1.2. Minor modifications to design, production processes or techniques do not necessarily require complete repetition of all first article design inspections. The extent of retest necessitated by such changes shall be determined by the contractor and approved by the government procuring activity. Where two or more printed wiring assemblies are electrically direct wired (joined without the use of connectors) and mechanically packaged together to form a replaceable functional assembly, the electrical and environmental tests shall be performed at the assembly level. This level is normally identified as the lowest replaceable unit from the standpoint of equipment maintenance.

First article approval is valid only on those contracts or purchase orders so designated by the Government procuring activity concerned. Failure to pass the tests defined in table IV per the sampling procedure shown in 4.4.1.1 and 4.4.1.2 shall necessitate corrective action to all assemblies that are to be delivered under the contract. Any corrective action requiring changes to the assembly procedure, design, process, etc. shall be reflected in the printed wiring assembly drawing and must be approved by the Government procuring activity.

4.4.1 Inspection routine. The first article inspection shall consist of the tests defined in table IV and on the approved assembly drawing, contract, or purchase order.

TABLE IV. First article inspection.

Test or Inspection	Requirement paragraph	Method paragraph
Components and materials	3.4 and see table I	4.3
Visual and mechanical examination Bow and twist	3.5 to 3.6.10 (inclusive) and 3.8.1	4.8.1 to 4.8.3
Electrical parameters	3.8.2	4.8.4
Vibration 1/	3.8.3	4.8.5
Shock 1/	3.8.4	4.8.6
Thermal shock	3.8.5	4.8.7
Temperature-altitude 1/	3.8.6	4.8.8
Humidity	3.8.7	4.8.9
Salt fog 1/	3.8.8	4.8.10
Fungus (separate sample) 1/	3.8.9	4.8.11

1/ When specified, the tests in table IV must be conducted on the completed printed wiring assemblies. Additionally, the contractor may wish to conduct certain of these tests at earlier stages of fabrication to ensure progress toward an acceptable assembly.

4.4.1.1 First article design inspection. One printed wiring assembly of each new assembly design shall be subjected to the first article inspection in accordance with table IV. Significant changes to existing designs may require additional design testing to assure design integrity is maintained. The contractor may wish to conduct certain of these tests at earlier stages of fabrication to ensure progress toward an acceptable assembly.

4.4.1.2 First article type inspection. Subsequent procurements of printed wiring assemblies which have previously passed first article design inspection shall be submitted to first article type inspection. Printed wiring assembly types are defined in 1.2.1. When type testing is to be performed, one printed wiring assembly of each type, a representative of the most complex assembly of each type in a single contract shall be selected by the contractor, and agreed to by the Government representative. The assembly selected for type testing shall be the first part produced by the production process. This type representative shall be subjected to the first article inspection of table IV.

4.4.2 Failures. When one or more samples fail to pass the first article inspection (see table IV) this shall be cause for refusal to grant first article approval.

4.4.3 Disposition of samples. Unless otherwise specified by the Government procuring activity, sample assemblies, which have been subjected to and have passed first article inspection, shall be disposed of in accordance with the manufacturer's disposal procedures.

4.4.4 First article approval. Approval of the first article in no way relieves the contractor of responsibility for complying with all requirements of the specifications, applicable assembly drawings, and all other terms and conditions of the contract, nor shall an approved first article be construed as altering or taking precedence over any of these requirements.

4.5 In-process inspection. In-process inspection shall consist of the examinations of 4.5.1 and the test of 4.5.2 as shown in table V.

4.5.1 Soldered connections inspections. Each soldered connection on each printed wiring assembly shall be visually inspected to the requirements of 3.5.3, using an optical apparatus or aid which provides a minimum magnification equivalent to a lens of 3 diopters (approximately 2.4x). Referee inspections may be accomplished at a mangification of 10x. Defective solder connections shall be reworked per 3.7.1 prior to further processing. Assemblies which do not meet the requirements of 3.5.3.2.1b shall be rejected.

4.5.2 Inspection lot for cleanliness verification. An inspection lot for cleanliness verification shall consist of all printed wiring assemblies processed through the cleaning process during a single shift. Immediately after cleaning and prior to conformal coating, five printed wiring assemblies per production shift shall be selected and subjected to the test of table V.

4.5.3 Failures. If one or more of the five printed wiring assemblies fail to meet the cleanliness and resistivity of solvent extract test of table V, the lot shall be rejected (see 4.5.4).

4.5.4 Rejected lots. When a lot is rejected as a result of a failure to pass the test specified in table V, the manufacturer shall withdraw the lot, take corrective action in connection with the cleaning materials and procedures, reclean the lot, and resubmit the lot to the test of table V. Such lots shall be separated from new lots, and shall be clearly identified as reinspected lots.

TABLE V. In-process inspection.

Test or inspection	Requirement paragraph	Method paragraph	Sampling plan
Cleanliness and resistivity of solvent extract	3.6.10	4.8.2	4.5.2
Visual of soldered connections	3.5.3	4.5.1	100%

4.6 Quality conformance inspection.

4.6.1 Inspection of printed wiring assemblies for delivery. Inspection of printed wiring assemblies for delivery shall consist of group A. Except as specified in 4.6.1.3.5, delivery of printed wiring assemblies which have passed the group A inspection shall not be delayed pending the results of the group B inspection.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table VI.

4.6.1.2.1 Group A inspection lot. An inspection lot for group A inspection shall consist of all printed wiring assemblies on a specific contract fabricated from the same design, using the same processing procedures, and produced under essentially the same conditions within a maximum period of 90 days and offered for inspection at one time.

4.6.1.2.2 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality level (AQL) shall be as specified in table VI. Major and minor defects shall be as defined in MIL-STD-105 and 4.8.1.1.

TABLE VI. Group A inspection.

Test or inspection	Requirement paragraph	Method paragraph	AQL (percent defective)	
			Major	Minor
Visual and mechanical	3.5 to 3.6.10 incl, 3.9, and 3.10	4.8.1 4.8.1.1	1%	4%
Electrical parameters	3.8.2	4.8.4	100%	test

4.6.1.2.3 Rejected lots. If an inspection lot (see 4.6.1.2.1) is rejected, the manufacturer shall withdraw the lot and take corrective action, or screen out the defective units and reinspect. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.6.1.2.4 Disposition of sample units. Samples subjected to group A inspection may be delivered with the order, if the inspection lot passes.

4.6.1.3 Group B inspection. Group B inspection shall consist of the tests specified in table VII, in the order shown and other such tests specified on the approved assembly drawing.

TABLE VII. Group B inspection.

Test or inspection	Requirement paragraph	Method paragraph
Thermal shock	3.8.5	4.8.7
Humidity	3.8.7	4.8.9
Electrical parameters	3.8.2	4.8.4

The tests in table VII must be conducted on the completed printed wiring assemblies. Additionally, the contractor may wish to conduct certain of these tests at earlier stages of fabrication to ensure progress toward an acceptable assembly.

4.6.1.3.1 Group B inspection lot. An inspection lot for group B inspection shall consist of all printed wiring assemblies of the same type (see 1.2.1) which have passed group A inspection. Board assemblies of the same type and fabricated to this specification may be grouped from different contracts to form a group B inspection lot.

4.6.1.3.2 Sampling plan. Once every 60 days, one printed wiring assembly of each assembly type (see 1.2.1) representative of the most complex assembly of each type shall be selected by the contractor and agreed upon by the Government representative and subjected to tests in table VII. The assembly selected shall have passed group A inspection and may be from one or more contracts unless otherwise specified on the approved assembly drawing.

4.6.1.3.3 Failures. If one or more samples fail to pass group B inspection, the lot shall be considered to have failed.

4.6.1.3.4 Disposition of samples. Unless otherwise specified by the Government procuring activity, sample assemblies which have been subjected to and have passed group B inspection shall be disposed of in accordance with the manufacturer's disposal procedures.

4.6.1.3.5 Noncompliance. If a sample fails to pass group B inspection, the manufacturer shall take corrective action on the materials or processes, or both, as warranted, and on all printed wiring assemblies which can be corrected and which were manufactured under esentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the printed wiring assemblies shall be discontinued until corrective action acceptable to the Government has been taken. After the corrective action has been taken, the group B inspection shall be repeated on additional sample assemblies. Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group B reinspection has shown that the corrective action was successful. In the event of failure, after reinspection, information concerning the failure and corrective action taken shall be furnished to the Government procuring activity for those printed wiring assemblies warranting corrective action.

4.7 Inspection of packaging. Except when industrial packaging is specified, the sampling and inspection of the preservation and interior package marking shall be in accordance with the group A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129. The inspection of industrial packaging shall be as specified in the contract (see 6.2).

4.8 Methods of examination and test.

4.8.1 Visual and dimensional examination. Completed printed wiring assemblies shall be examined to verify that the materials, construction, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.9, and 3.10). Examination shall be accomplished utilizing an optical apparatus or aid which provides a minimum magnification equivalent to a lens of 3 diopters (approximately 3/4X). Referee inspections may be accomplished at a magnification of 10X.

4.8.1.1 Classificaton of defects. Unless otherwise specified on the assembly drawing, the classification of defects for visual and dimensional examination shall be as specified herein. A suggested coding system is indicated to allow the use of an automatic data processing system so that a particular coded number will be applicable only to a specific kind of defect. The letter "A" is for major defects and "B" for minor defects.

Defect code number	Major defects
A1	Wrong parts used.
A2	Wrong printed wiring board used.
A3	Solder bridging between adjacent circuits, protrusions, or peaks that reduce the distance between an element of one circuit and an adjacent circuit or conducting material below the minimum specified on the printed wiring board assembly drawing.
A4	Solder on component side of single-sided boards.
A5	Solder on surfaces designated to be free of solder.
A6	Features, conductor patterns, interfacial connections, jumpers, and components not in accordance with the assembly drawing or approved drawing referenced therein.
A7	Holes in the board which are not specified on the assembly drawing or master drawing referenced therein.
A8	Corrosion on the metal surfaces.
A9	Printed wiring conductors loose or missing.
A10	Components mounted in the wrong locations on the board.
A11	Wrong orientation of polarized components.
A12	Misalinement of lead wires with respect to land areas (see 3.5.1.4).
A13	Jumper wires not as specified on the assembly drawing.
A14	Jumper wires that terminate at locations other than terminal areas.
A15	Component leads used as jumper wires.
A16	Jumper wires routed over or under components.
A17	Inadequate spacing between uninsulated jumper wires or lead wires and adjacent conductors.
A18	Absence of insulation sleeving on jumper wires, when specified, (see 3.5.1.10).
A19	Poor wetting of solder to the basis metal, as evidenced by convex fillets, nonwetting and dewetting (not in excess of that allowed in IPC-S-815), cold joints, rosin joints, etc.
A20	Cracked solder joints, as evidenced by cracks or other discontinuities.
A21	Excess solder on joints.
A22	Insufficient solder on joints.
A23	Welds not in compliance with the assembly drawing.
A24	Bow and twist in excess of that permitted by the assembly drawing.
A25	Inadequate cleanliness of the printed wiring assembly as evidenced by the presence of dirt, foreign matter, oil, fingerprints, corrosion, salts, flux residues, and contaminants.
A26	Measling in excess of that allowed in 3.5.3.4.
A27	Conformal coating containing bubbles or pinholes in excess of that allowed in 3.6.
A28	Conformal coating exhibiting blisters, cracking, crazing, mealing, peeling, wrinkles, or reversion.
A29	Unauthorized repair.

Defect code number	Major defects
A30	Printed wiring assemblies that are charred, burned, blistered, chipped, gouged, delaminated, or otherwise damaged.
A31	Identification markings illegible or missing from the printed wiring assembly.
A32	Incorrect identification marking on the printed wiring assembly.
A33	Leakage from oil-impregnated or electrolytic components.
A34	Physical damage to parts resulting from the straightening, cutting, bending, inserting, or clinching of wire leads.
A35	Chipped, cracked, or broken parts.
A36	Wire leads which have been broken or nicked exposing basis metal.
A37	Loose parts not securely attached or supported on the board.
A38	Deformation of lead diameter greater than 10 percent.
A39	Electrically functional plated-through hole with a lead, without solder plug.
A40	Greater than 2 percent of all plated-through holes (electrically functional or not, without a lead) that are subjected to wave or dip soldering without a solder plug.
	Minor defects
B1	Part polarity markings illegible (except as permitted for automatic insertion and lead forming equipment).
B2	Part identification markings illegible (except as permitted for automatic insertion and lead forming equipment).
B3	Thickness of conformal coating not within specified limits.
B4	Inadequate coverage of conformal coating on the printed wiring assembly.

4.8.2 Cleanliness and resistivity of solvent extract (see 3.6.10).

4.8.2.1 Preparation of solvent extract test solution. Prepare a test solution of 75 percent by volume ACS reagent grade isopropyl alcohol and 25 percent by volume distilled/deionized water. Pass this solution through a mixed bed deionizer cartridge (Barnstead D8902, Ultra-Purse, Hose-Nipple Cartridge, or equal). After passage through the cartridge, typical resistivity of the solution will be 25×10^6 ohm-cm (conductivity - 0.04 micromho/cm). Replacement of the deionizer cartridge shall be required when the resistivity of the solution is of value less than 6×10^6 ohm-cm (conductivity - greater than 0.166 micromho/cm) (see 6.6). Replacement of the solvent extract solution shall be required when the resistivity of the solution is of a value less than 2×10^6 ohm-cm (conductivity - greater than 0.50 micromho/cm) (see 3.6.10.1).

4.8.2.2 Preparation for test. Position a convenient sized polyethylene funnel over a suitable polyethylene container. Premark the container for the volume of test solution required for the test. Suspend the printed wiring assembly within the funnel.

4.8.2.3 Test procedure. Direct the test solution, in a fine stream, onto both sides of the assembly until 10 ml of test solution is collected for each square inch of assembly area. Assembly area includes the area of both sides of the board plus an estimate of the area of the components mounted thereon. Wash the assembly for a minimum of 1 minute. It is imperative that the initial washings be included in the test sample. Measure the resistivity/conductivity of the collected test solution with a conductivity bridge or other instrument of equivalent range and accuracy. NOTE: All laboratory ware must be scrupulously clean. Preferably, laboratory ware used for this test should be reserved for this test and not used elsewhere (see 6.6). Alternate test methods specified in 3.6.10.1 and 6.6.1 may be used.

4.8.3 Bow and twist (see 3.8.1). Bow, twist, or any combination thereof, shall be determined by physical measurement and percentage calculation. The calculation shall be based on the formula:

$$\% = \frac{D}{L} \times 100, \text{ where:}$$

D = the measured deviation, worst case, of the assembly mounting surface from a true plane best approximating the mounting surface. Use the cumulative plus and minus planer deviations.
L = the measured breadth dimension of the board along the direction of the board's greatest degree of curvature.

4.8.3.1 Practical measurement of "D". Stand the assembly on two extremeties of the board, at a zero planar reference. Rock the board so the two other points of greatest deviation from zero are equally displaced from zero ("twist" predominant), or rock the board so the two other diagonal extremes closest to zero are equally displaced from zero ("bow" predominant). Measure the displacement from zero at the point on the mounting surface farthest from zero.

4.8.3.2 Practical measurement of "L".
a. Twist predominant; measure the diagonal of the board along the direction of greatest apparent curvature.
b. Bow predominant; measure the width or length of the board along the side most greatly curved.

4.8.4 Electrical parameters (see 3.8.2). Completed printed wiring assemblies shall be tested as specified on the assembly drawing.

4.8.5 Vibration (see 3.8.3). Completed printed wiring assemblies shall be tested in accordance with method 514, procedure I, of MIL-STD-810 with the following details:.

a. Curve - E, unless otherwise specified (see 6.2).
b. Fixture - Hard mount.
c. Test procedures - The accelerometer shall be mounted at the center of the unit. The "g" input to the board shall be reduced so that the maximum unit output, at the center of the board, does not exceed 100 g's.
d. Electrical tests - Unless otherwise specified (see 6.2), the electrical tests shall be conducted as specified in 4.8.4 after the vibration test.

4.8.6 Shock (see 3.8.4). Completed printed wiring assemblies shall be tested in accordance with method 516, procedure I, of MIL-STD-810 with the following details:

a. Shock pulse - Half sine, 6.5 ±0.1 ms; 100 g's, unless otherwise specified (see 6.2).
b. Fixture - Hard mount.
c. Electrical tests - Unless otherwise specified (see 6.2), the electrical tests shall be conducted as specified in 4.8.4 after the shock test.

4.8.7 Thermal shock (see 3.8.5). Completed printed wiring assemblies shall be tested in accordance with method 107, Test condition A-3, of MIL-STD-202.

4.8.8 Temperature-altitude (see 3.8.6). Completed printed wiring assemblies shall be tested in accordance with method 504 of MIL-STD-810. Temperature and altitude shall be as specified in the engineering drawing (see 6.2).

4.8.9 Humidity (see 3.8.7). Completed printed wiring assemblies shall be tested in accordance with method 507, procedure I, of MIL-STD-810.

4.8.10 Salt fog (see 3.8.8). Completed printed wiring assemblies shall be tested in accordance with method 509, procedure I, of MIL-STD-810.

4.8.11 Fungus (see 3.8.9). Completed printed wiring assemblies shall be tested in accordance with method 508, procedure I, of MIL-STD-810. Data available on materials as to conformance with this test will suffice.

5. PACKAGING

5.1 Preservation. Preservation shall be level A, C, or industrial, or as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning. Printed wiring assemblies shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Printed wiring assemblies shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. Preservatives shall not be used.

5.1.1.4 Unit packs. Each printed wiring assembly shall be individually unit packed in accordance with MIL-P-116, submethod IA-8 insuring compliance with the applicable requirements of that specification. Cushioning shall conform to PPP-C-1842, type III. When electrostatic and/or electromagnetic protection is required, the unit container shall be in accordance with the requirements of MIL-B-81705, type 1. Each unit pack shall be placed in a supplementary container conforming to PPP-B-566 or PPP-B-676.

5.1.1.5 Intermediate packs. Intermediate packs are not required.

5.1.2 Level C. The level C preservation for printed wiring assemblies shall meet the requirements specified for level A except that nonspecification versions of the electrostatic protective cushioning and supplementary containers may be used.

5.1.3 Industrial. The industrial preservation of printed wiring assemblies shall be in accordance with the requirements of MIL-STD-1188.

5.2 Packing. Packing shall be level A, B, C, or industrial, or as specified (see 6.2).

5.2.1 Level A. The packaged printed wiring assemblies shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. In lieu of the closure and waterproofing requirement in the appendix of PPP-B-636, closure and waterproofing shall be accomplished by sealing all seams, corners and manufacturer's joints with tape, two inches minimum width, conforming to PPP-T-60, class 1 or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636 using nonmetallic or tape banding only.

5.2.2 Level B. The packaged printed wiring assemblies shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirements. Closures shall be in accordance with the appendix thereto.

5.2.3 Level C. The level C packing for printed wiring assemblies shall conform to the MIL-STD-794 requirements for this level.

5.2.4 Industrial. The preserved printed wiring assemblies shall be packed in accordance with the requirements of MIL-STD-1188.

5.3 Marking. In addition to any special or other identification marking required by the contract (see 6.2), each unit, supplementary and exterior container shall be marked in accordance with MIL-STD-129. Industrial marking shall be in accordance with the requirements of MIL-STD-1188. Regardless of type of packaging specified, the sensitive electronic device symbol and associated caution label shall be marked as specified in MIL-STD-129 on all units, supplementary and exterior containers.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2 and 5.2.3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Packaging inspection. The inspection of these packaging requirements shall be in accordance with 4.7.

5.4.3 Army procurements.

5.4.3.1 Level A unit packs. All supplementary containers shall be either weather (or water) resistant or overwrapped with waterproof barrier materials (see 5.1.1.4).

5.4.3.2 Level A and level B packing. For level A packing the fiberboard containers shall not be banded but shall be placed in a close fitting box conforming to PPP-B-601, overseas type; PPP-B-621, class 2, style 4 or PPP-B-585, class 3, style 2 or 3. Closure and strapping shall be in accordance with applicable container specification except that metal strapping shall conform to QQ-S-781, type I, finish A. When the gross weight exceeds 200 pounds or the container length and width is 48 x 24 inches or more and the weight exceeds 100 pounds, 3 x 4 inch skids (laid flat) shall be applied in accordance with the requirements of the container specification. If not described in the container specification, the skids shall be applied in a manner which will adequately support the item and facilitate the use of material handling equipment. For level B packing, fiberboard boxes shall be weather resistant as specified in level A and the containers shall be banded (see 5.2.1 and 5.2.2).

6. NOTES

6.1 Waiver of testing. The Government procuring activity may wish to waive certain environmental tests based on testing the next higher assembly; however, the cleanliness test and electrical tests should not be waived. Relying solely on tests at the next higher assembly may result in inadequate or unproven documentation for procurement of replacement items. This consideration should be made prior to request for quote.

6.2 Ordering data. The acquisition document should specify the following:

a. Title, number, and date of this specification.
b. Type of printed wiring assembly required (see 1.2.1).
c. Title, number, and date of applicable assembly drawing (see 3.1).
d. Environmental tests, if any, which may be deferred to testing of the next higher assembly (see 3.1 and 6.1).
e. Salt fog, if required (see 3.8.8).
f. Thermal shock test condition required (see 3.8.5).
g. Temperature-altitude 1/, if required (see 3.8.6.).
h. Vibration frequency, if other than specified; maximum size of accelerometer, where critical; normal mounting means where used in lieu of the hard mounting specified (see 4.8.5).
i. Continuous electrical operation during vibration, if required (see 3.8.3).
j. Shock force, if other than specified (see 3.8.4).
k. Continuous electrical operation during shock, if required (see 3.8.4).
l. Delivery of first article samples (see 4.4).
m. Disposition of group B samples (see 4.6.1.3.4).
n. Inspection of industrial packing (see 4.7).
o. Levels of preservation and packing required (see 5.1 and 5.2).
p. If special or other identification marking is required (see 5.3).

1/ Normally for airborne applications only.

6.3 First article inspection. Information pertaining to first article inspection of products covered by this specification should be obtained from the procuring activity for the specific contracts involved.

6.4 Flux removal. Selection of procedures for flux removal is at the contractor's discretion. A procedure must be chosen which will enable the printed wiring assembly fabricator to produce results enabling compliance with 3.5.3.3. Both polar and nonpolar solvents may be required to effect adequate flux removal.

6.5 Plastic bags. Where plastic bags are used for packaging printed wiring assemblies, they shall be clean and free from ionic contaminants. (The resistivity of solvent test in 4.8.2 can be used to determine the degree of ionic contamination.) NOTE: Printed wiring assemblies which contain parts sensitive to electrostatic damage should not be packaged in plastic bags, unless the bags have been treated to permanently prevent build-up of electrostatic charges (see 5.1).

6.6 Resistivity of solvent extract (see 4.8.2). This test procedure, including solution preparation and a laboratory ware cleaning procedure, is documented in Materials Research Report No. 3-72, "Printed-wiring assemblies; detection of ionic contaminants on". Application for copies of this report should be addressed to the Commander, Naval Avionics Facility, Indianapolis, IN 46218.

6.6.1 Alternate methods. The following methods of determining the cleanliness of printed wiring assemblies have been shown to be equivalent to the resistivity of the solvent extract method in 6.6:

a. The Kenco Alloy and Chemical Company, Incorporated, "Omega Meter ™, Model 200".
b. Alpha Metals Incorporated, "Ionograph ™".
c. E. I. Dupont Company, Incorporated, "Ion Chaser ™."

Test procedures and calibration techniques for these methods are documented in Materials Research Report 3-78. "Review of Data Generated With Instruments Used to Detect and Measure Ionic Contaminants on Printed-Wiring Assemblies". Application for copies of this report should be addressed to the Commander, Naval Avionics Center, Indianapolis, IN 46218. Table VIII lists the equivalence factors for these methods in terms of microgram equivalents of sodium chloride per unit area:

TABLE VIII. Equivalence factors.

Method	= X μgNaCl/in²		Instrument "Acceptance limit"	
		Equivalence factor	μgNaCl/Cm²	μgNaCl/in²
MIL-P-28809-Beckman	7.47	$\frac{7.545}{7.545} = 1$	1.56	10.06
MIL-P-28809-Markson	7.62 (7.545)	$\frac{7.545}{7.545} = 1$	1.56	10.06
Omega Meter	10.51	$\frac{10.51}{7.545} = 1.39$	2.2	14
Ionograph	15.20	$\frac{15.20}{7.545} = 2.01$	3.1	20
Ion Chaser	24.50	$\frac{24.50}{7.545} = 3.25$	5.1	32

6.7 Ultrasonic cleaning. Ultrasonic cleaning may damage certain component parts, particularly integrated circuits and semiconductors, and should not be used.

6.8 Sensitive-component handling. To prevent damage by static electricity, persons coming into contact with or handling of electro-sensitive components, such as some semiconductors should be grounded prior to touching or installing the component. Certain electro-sensitive devices may require additional precautions and should be handled in accordance with manufacturer's recommendations.

6.9 Changes from previous issue. Asterisks are not used in this revision to denote changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army - ER
Navy - EC
Air Force - 17

Review activities:
Army - MI, AR, ME, AT
Navy - SH, OS
Air Force - 85, 99
DLA - ES
NS - S23

User activity:
Navy - AS, MC

Agent:
DLA - ES

Preparing activity:
Navy - EC

(Project 5999-0103)

APPENDIX

REPAIR AND MODIFICATION OF PRINTED WIRING ASSEMBLIES

10. SCOPE

10.1 Purpose. This appendix establishes requirements for the repair and modification of printed wiring assemblies produced in accordance with this specification.

10.2 Authorization.

10.2.1 Repair authorization. Standard repairs (see 30.1.12 and 50.2) covered by this appendix may be used when the contractor has Material Review Board (MRB) delegation on the contract. Authorization for these standard repairs shall be individually authorized by the contractors material review procedure, with concurrence by the cognizant government representative.

Alternately, the contractor may request authorization to perform standard repairs using in-house control systems other than MRB action. These alternate methods require approval of the Government procuring activity and must demonstrate that standard repairs are documented and that there is traceability to the assemblies to which the repairs are applied.

Repairs other than the standard repairs contained herein require written authorization of the Government procuring activity. Authorization of other repairs is applicable only to the contract under which the repair authorization was granted.

10.2.2 Modification authorization.

10.2.2.1 Prototype modification authorization. Modification of prototype assemblies may be performed by the contractor when the details of the modification are determined and defined in sufficient detail, acceptable to the Government procuring activity, to assure adequate documentation of the modification(s). Details of the modifications shall be added to the design package and shall be submitted to the Government procuring activity for post incorporation review. Prototype modifications which are to be incorporated in the production articles shall be incorporated into the design prior to the start of production.

10.2.2.2 Production modification. Modification of production printed wiring assemblies requires written authorization of the Government procuring activity. Documentation of modifications shall be as specified herein (see 40.4). Modification authorizations are limited to the contract under which the authorization was granted, until the printed wiring master drawing and/or the printed wiring assembly drawing has been changed and approved to reflect the modification.

10.3 Unassembled boards. The repair or modification of unassembled (bare) printed wiring boards shall not be permitted.

20. APPLICABLE DOCUMENTS

20.1 Government documents. Unless otherwise specified, the following specifications and standards, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards specified in the solicitation, form a part of this appendix to the extent specified herein.

DRAWINGS

MILITARY

NAVAIR 20DAS107-1 - Adhesive, Epoxy, Flexible.

REPORTS

MILITARY

NAFI Materials Research Report No. 3-70	- Welded Repair of Severed Conductors on Printed Wiring Assemblies.
NAFI Materials Research Report No. 3-72	- Printed Wiring Assemblies; Detection of Ionic Contaminants On.
Naval Air Center Materials Research Report No. 3-78	- Review of Data Generated with Instruments used to Detect and Measure Ionic Contaminants on Printed Wiring Assemblies.

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

30. DEFINITIONS

30.1 Terms and definitions. The definitions of all terms used herein shall be as specified in ANSI/IPC-T-50 and the following:

30.1.1 Automated component insertion. Automated component insertion is the act or operation of assembling discrete components to printed boards by means of computer-controlled component-insertion equipment.

30.1.2 Buffer material. A resilient material which is used to protect crack-sensitive components from excessive stresses generated by the conformal coating.

30.1.3 Circuit card assembly. A circuit card assembly is a grouping of two or more physically connected or related electrical and/or electronic parts capable of disassembly. Each component of the assembly must be capable of functioning in accordance with its own item name. Consists of a printed-wiring board upon which are mounted separately manufactured electronic componenets, such as capacitors, inductors, resistors, and the like. It may also include printed electronic components. (Source: H6).

30.1.4 Component. A component is a separate part of a printed-circuit assembly or printed-wiring assembly which performs a circuit function (e.g. resistor, capacitor, transistor, transformer, etc.).

30.1.5 Component mounting. Component mounting is the act of mechanically attaching the component to the printed board, or the manner in which they are attached, or both.

30.1.6 Component orientation. Component orientation is the direction in which the components, on a printed board or other assembly, are lined-up electrically with respect to the polarity of polarized components and also with respect to one another and to the board.

30.1.7 Cracking. Cracking is that phenomena manifest in coatings by a break extending through to the base surface.

30.1.8 Hard wiring. Hard wiring is electrical wiring that interconnects two or more parts or assemblies into an assembly which is inseparable without the use of special tools and techniques.

30.1.9 Modification. Modification is defined as a revision to the interconnect features on a printed wiring assembly accomplished by interrupting conductors, adding/deleting components and/or adding wires. Modification of a printed wiring assembly is done in lieu of using a new-design assembly with the changes incorporated in the conductor pattern, drilled features, or other characteristics changed by the revision.

30.1.10 Repair. A repair is any correctional process not sanctioned by the assembly's design documentation. The purpose of a repair is to restore the usability of a damaged or defective assembly without having to totally replace the discrepant member of the assembly.

30.1.11 Rework. Reworking is the act of reestablishing the functional and physical characteristics of an assembly without deviating from the original design drawing, specifications, or contract requirements. The reworking of defective solder connections or replacement of defective component is not considered to be a modification or repair and is permissible.

30.1.12 Standard repairs. Standard repairs are those repair techniques described by this specification, not exceeding the numerical limits set.

30.1.13 Standoff terminal. A standoff terminal is a terminal generally postlike, having an axial portion of its body designed for projecting through or into a board for mounting. (See figure 1).

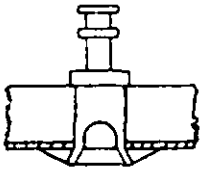


FIGURE 1. Standoff terminal.

30.1.14 Straight-through lead. A straight-through lead is a component lead wire that is not clinched or swaged after insertion in a hole of a printed-wiring board. (See figure 2).

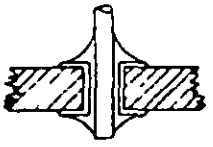


FIGURE 2. Straight through lead.

40. GENERAL

40.1 Quality. Limited repair or modification of printed wiring assemblies may be necessary in the interest of economy or delivery. It is essential that such repairs and modifications be accomplished in a manner which will not degrade the quality of the products.

40.2 Performance. Repaired or modified printed wiring assemblies shall meet the performance requirements and quality assurance provisions of this specification.

40.3 Spacings. Repair shall not reduce circuitry spacing below that provided by design. The cross sectional area of wires, leads, or copper strips shall be equal to or larger than the replaced conductor.

40.4 Documentation of modification. Documentation of modification on prototypes and printed wiring assemblies under production shall be as specified herein.

40.4.1 Documentation of prototypes. Details of the modification to a prototype of a printed wiring assembly shall be prepared and added to the data design package.

40.4.2 Documentation of production. Upon approval from the Government procuring activity of a modification change, the board assembly fabricator shall take the appropriate action to reflect the approved change and production will continue on the next assemblies. At all times the data package shall be kept updated with documentation to reflect modified or unmodified assemblies and their approved changes. Part numbers shall be changed if the modified or unmodified assemblies are not physically or electrically interchangeable (i.e., form, fit or function).

40.5 Cleanliness. Coated and uncoated, modified or repaired printed wiring assemblies shall be free of flux, flux residues, and other contaminants prior to the application of conformal coating (see 40.6.2.1). The Government reserves the right to require confirmation that all coated and uncoated, modified or repaired printed wiring assemblies were inspected for flux residues after modification or repair.

40.5.1 Resistivity of solvent extract. When required by the Government procuring activity, coated or uncoated, modified or repaired printed wiring assemblies shall be tested as specified in 50.3. The resistivity shall be not less than 2,000,000 ohm-cm (or equivalent) (see 50.3.4.1). The equivalent test methods and factors specified in 50.3.4.1 may be used in lieu of the method specified in 50.3. Other equivalent test methods not specified in 50.3.4.1 may be used in lieu of 50.3 only when specifically approved by the Government procuring activity. Such approval will be determined on the basis that the alternate method is demonstrated to have equal or better sensitivity and employs solvents with the ability to dissolve flux residue as does the alcohol water solution specified in 50.3.

40.6 Materials. Materials used in modification and repair shall be as specified herein or on the assembly drawing.

40.6.1 Solder. The solder used shall be in accordance with composition Sn 60, Sn 62 or Sn 63 of QQ-S-571. For wave or dip soldering, use bar solder, form B. For hand soldering, use solder wire form W, either solid metal, type S, or with a core of either type R, RMA, or RA of QQ-S-571, with the exception that RA flux shall not be used on stranded wire. (With special approval type RA flux may be used on Army ERADCOM, CORADCOM and AVRADCOM contracts).

40.6.2 Soldering flux. Soldering flux shall be a liquid flux conforming to MIL-F-14256, type R, RMA, or RA, with the exception that RA flux shall not be used on stranded wire. (With special contract approval, type RA flux may be used on Army ERADCOM, CORADCOM, and AVRADCOM contracts). If the resistivity of solvent extract test or equivalent cannot be performed, type RA flux shall not be used (see 40.5.1).

40.6.2.1 Flux removal. Selection of procedures for flux removal is at the contractor's discretion. A procedure shall be chosen which will enable the printed wiring assembly to be in compliance with 40.5. Both polar and nonpolar solvents may be required to effect adequate flux removal. The procedure chosen should not degrade markings, components, or board materials.

40.6.3 Adhesive. Epoxy structural adhesive shall be in accordance with NAVAIR Drawing No. 200A5107-1 or as specified on the approved assembly drawing or approved standard repair procedure. Conformal coating shall not be relied upon in place of adhesive.

40.6.4 Conformal coating. Conformal coating shall be type UR, ER, AR, SR, or XY per MIL-I-46058. The thickness of the conformal coating shall be as follows for the type specified. Measurement shall be on a flat unencumbered surface (see MIL-I-46058). Coating thickness in any areas of overlap may be within twice the specified coating thickness.

a. Types ER, UR, and AR: 0.003 ±0.002 inch.
b. Type SR: 0.005 ±0.003 inch.
c. Type XY: 0.0005 to 0.002 inch.

40.6.5 Hook-up wire. Hook-up wire for added wires shall be:

a. Solid copper conductor, tin-plated, with a compatible jacket.
b. Tin-coated copper wire, per QQ-W-343, type S, soft or drawn and annealed.

40.6.6 Insulation tubing. Polytetrafluoroethylene tubing used for insulating hook-up wires shall be in accordance with MIL-I-22129, etched for bonding.

40.7 Coating area. Repaired circuitry shall be covered with epoxy adhesive or conformal coating for a minimum of 0.030 inch beyond the end of the repair area except in special areas (e.g., printed edgeboard contacts, etc.,) where the assembly drawing specifies that these areas be exposed. The conformal coating shall be a material that conforms to 40.6.4.

40.8 Component replacement. Repairs shall be made so that components may be replaced without damaging the repaired area

40.9 Workmanship. Modified or repaired printed wiring assemblies shall be clean and free of dirt, foreign matter, oil, fingerprints, corrosion, salts, flux residues, and other contaminants, and meet the requirements of this specification.

50. DETAIL REQUIREMENTS

50.1 Standard modifications.

50.1.1 Conductor removal.

50.1.1.1 Minimum removal. Unless otherwise limited by design constraints, a minimum of 0.030 inch of conductor shall be removed where the circuit is to be interrupted (see figure 3).

50.1.1.2 Circuit junctions. Unless otherwise limited by design constraints, conductors shall not be cut or removed within 0.010 inch of land areas or circuit junctions (see figure 3).

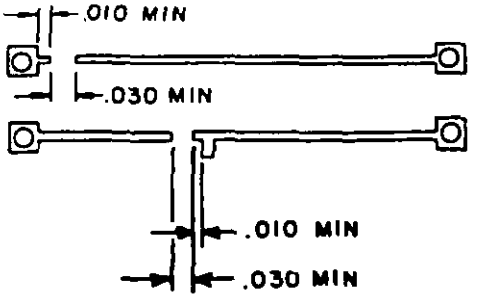


FIGURE 3. Removal of conductors.

50.1.1.3 After removal. The area under the circuits removed shall be inspected to assure that all traces of conductor are removed. The glass cloth shall not be scraped into and the coupling agent shall not be scraped away from the glass filaments. This area shall then be covered with epoxy adhesive or approved conformal coating (see 40.6.4).

50.1.2 Added wires.

50.1.2.1 Insulation and sleeving. All added wires greater than 0.50 inch in length shall be insulated or sleeved.

50.1.2.2 Number of attachments. A maximum of two wires or leads may be attached to any termination except:

a. Wires or leads shall be attached to any flat pack lead in accordance with figures 4 and 4A.
b. When wires or leads are to be attached to DIP type components, terminations shall be made in accordance with figure 5.
c. No more than one wire shall be added to each connector tang and shall be attached in accordance with figure 6.
d. When large standoff terminals are used which have provision for additional attachments.
e. No wires shall be attached to the mating contact surfaces of connectors.

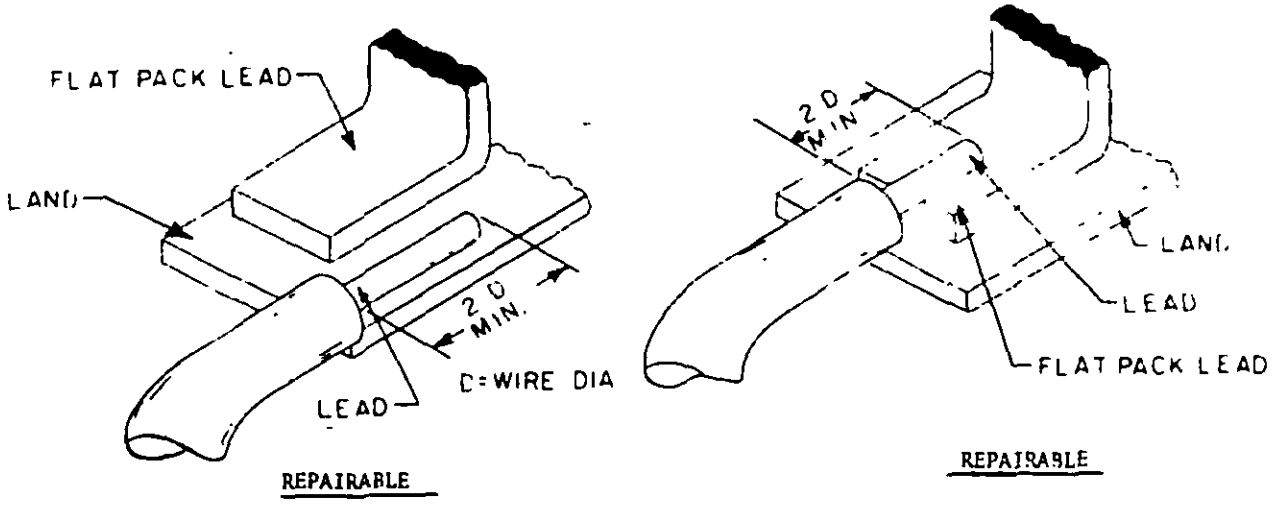


FIGURE 4. Flatpack (one wire or lead attached).

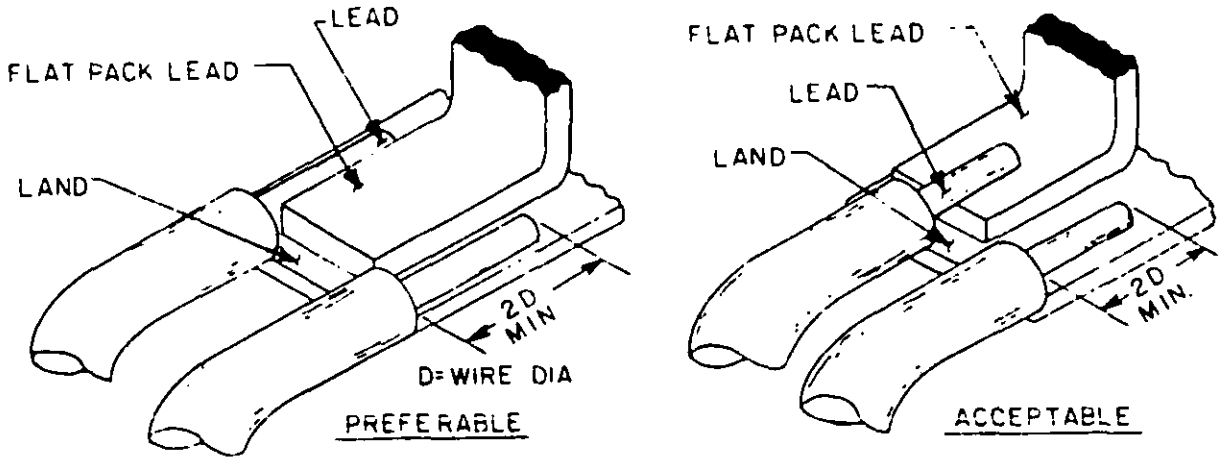


FIGURE 4A. Flatpack (2 wires or leads attached).

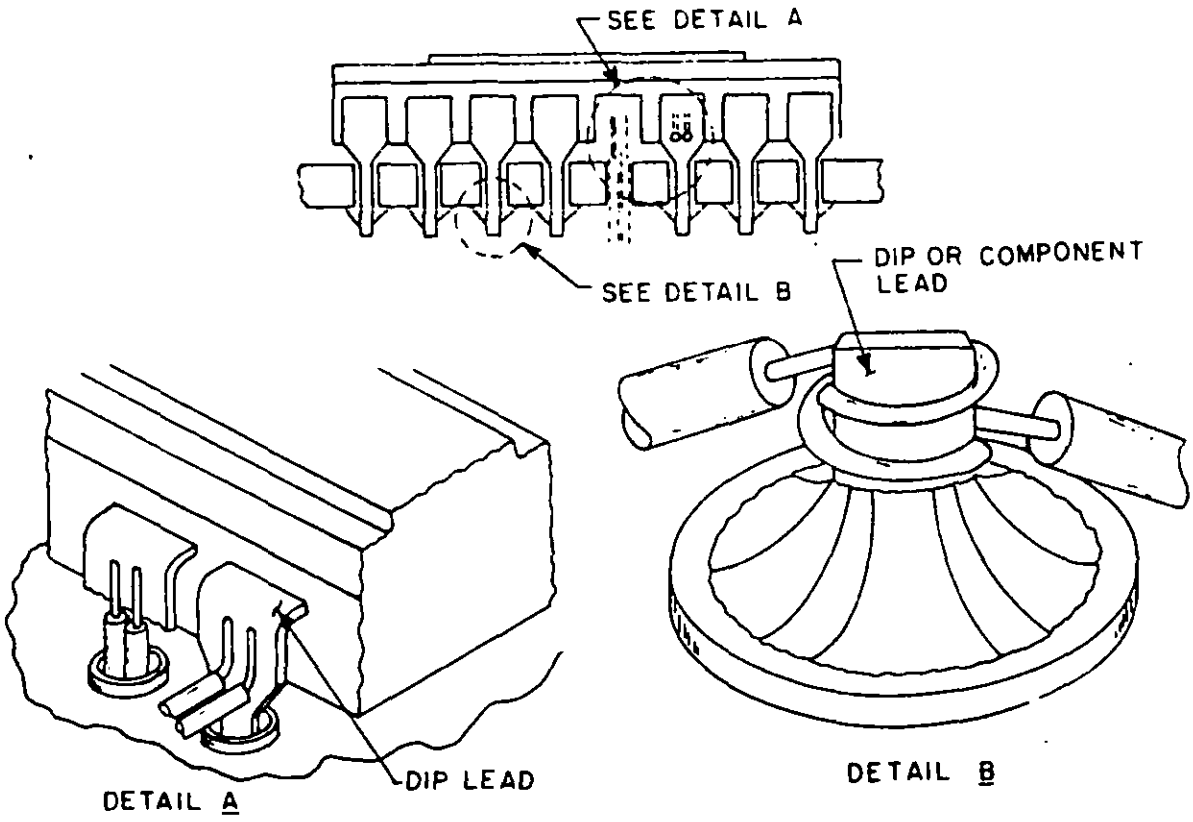


FIGURE 5. Dip type component.

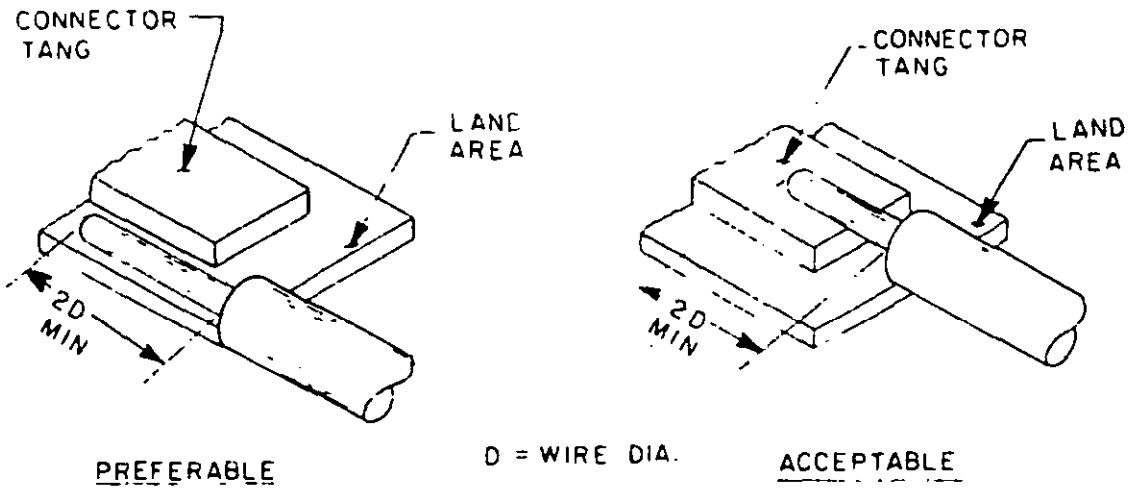


FIGURE 6. Connector tang.

50.1.2.3 Routing. Wires shall be routed in the X and Y directions (no diagonal lines permitted) by the shortest practical route and minimizing wire crossings unless otherwise specified by the revision. Added wires shall not cover plated-through component mounting holes. Wire routings on boards having the same part number shall be routed the same.

50.1.2.4 Preferred termination. Wires shall be connected at a point where heating to remove an adjacent component will not cause the wire to become unsoldered. Unused through holes are the preferred termination for wires.

50.1.2.5 Land area distance. Unless otherwise limited by design constraints, when wires are soldered directly to the conductor there shall be a minimum distance of 0.050 inch from the land area (see figure 7).

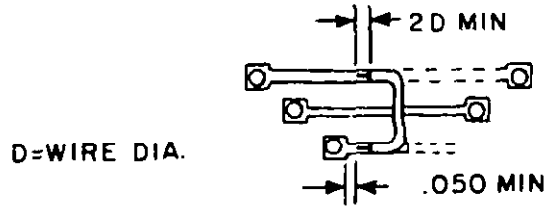


FIGURE 7. Positioning wiring on circuits.

50.1.2.6 Wire diameter. The diameter of the wire soldered directly to a conductor path shall not exceed the width of the conductor path and shall be positioned, where possible, as shown in figure 7 and in such a manner that the minimum electrical spacing is maintained. The wire shall contact the conductor path a minimum of two wire diameters at each end.

50.1.2.7 Securing of wires. Wires shall be secured to the board except where they pass through pin fields or where a 1 inch or shorter wire has both ends terminated in plated-through holes.

50.1.2.8 Existing terminals. When wires or leads are added to existing terminals, they shall be attached above the conformally coated area or the conformal coating shall be removed prior to attachment.

50.1.3 Added components.

50.1.3.1 Land area distance. When component leads are soldered directly to the conductor, there shall be a minimum clearance of 0.050 inch from a land area (see figure 7).

50.2 Standard repairs.

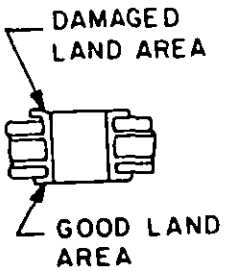
50.2.1 Land area.

50.2.1.1 Maximum permitted. The maximum number of land area repairs permitted per board shall be in accordance with table 1.

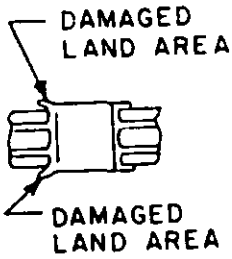
TABLE I. Maximum number of land repairs.

Board size (x)	Maximum number allowed
Square inches	
$x < 20$	3
$20 \leq x < 50$	6
$50 \leq x < 100$	9
$100 \leq x$	12

50.2.1.2 Connecting land areas. Repair of both land areas on both sides of a hole which connects internal circuits is prohibited (see figure 8).



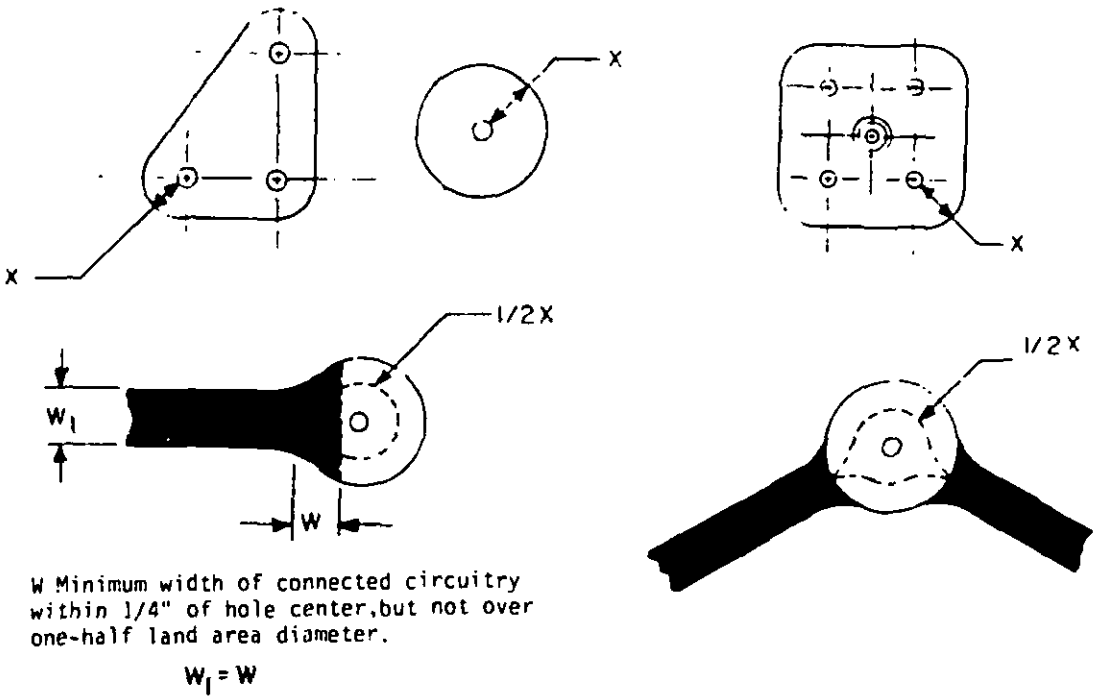
REPAIRABLE



NONREPAIRABLE

FIGURE 8. Repair limitations.

50.2.1.3 Lifted land areas. Any land which has been separated, loosened, lifted or which has otherwise become unbonded from the base material may be repaired by rebonding with an approved epoxy adhesive (see 40.6.3), provided that the maximum feeler gauge penetration is equal to 1/2x (see figure 9).



W Minimum width of connected circuitry within 1/4" of hole center, but not over one-half land area diameter.

$W_1 = W$

FIGURE 9. Land areas.

50.2.1.4 Repair visibility. All repairs shall be visible after soldering. Repairs to land areas that will subsequently be covered by flush mounted components (transistors, transformers, etc.) shall be inspected prior to installation of said components.

50.2.2 Conductor.

50.2.2.1 Maximum permitted. The maximum number of conductor repairs permitted per board shall be in accordance with table II.

TABLE II. Maximum number of conductor repairs.

Board size (x)	Maximum number allowed
Square inches	
$x < 20$	3
$20 \leq x < 50$	6
$50 \leq x < 100$	9
$100 \leq x$	12

50.2.2.2 Unbonded conductors. Unless otherwise limited by design constraints, unbonded conductors no more than 0.500 inch in length may be rebonded to the base laminate with approved epoxy adhesive material (see 40.6.3) extending a minimum of 0.030 inch beyond the lifted area in all directions.

50.2.2.3 Conductor breaks and defects. Unless otherwise prohibited by design constraints, conductor breaks, scratches, or similar defects no more than 0.500 inch in length may be repaired by use of a repair conductor, which shall overlap the original conductor by 0.125 to 0.250 inch at each end. If the conductor is lifted in the defective area, it shall be trimmed back to where a good bond exists. The repair conductor shall be centered over the original conductor. The repair conductor shall be formed to the board unless the conductor break is small (less than 0.100 inch) (see figure 10). Welded repairs shall be made as specified in NAFI Materials Research Report No. 3-70.

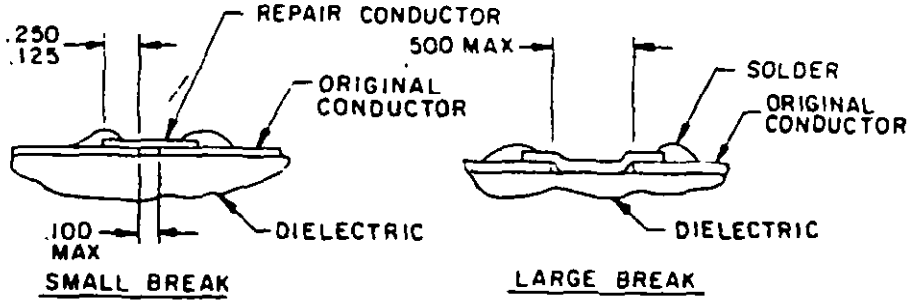


FIGURE 10. Repair of conductor breaks.

50.2.2.4 Sleeved conductors. Conductor defects of any length may be repaired by routing a sleeved conductor between the breaks or between terminations. When attached to a conductor line only, the repair conductor shall contact the original conductor a minimum of 0.125 inch from each end, unless otherwise limited by design constraints. The sleeved conductor shall be firmly secured to the board by an approved epoxy adhesive (see 40.6.3). Jumper wires shall be on the component side of the board and shall be routed in the X and Y directions by the shortest practical route minimizing wire crossings.

50.2.3 Plated-through holes with no internal connections.

50.2.3.1 Maximum permitted. The maximum number of open plated-through hole repairs permitted per board shall be in accordance with table III.

TABLE III. Maximum number of open plated-through hole repairs.

Board size (x)	Maximum number allowed
Square inches	
$x < 20$	3
$20 \leq x < 50$	6
$50 \leq x < 100$	9
$100 \leq x$	12

50.2.3.2 Shorted plated-through holes. Shorted plated-through holes in multilayer boards shall not be repaired.

50.2.3.3 Open plated-through holes.

50.2.3.3.1 Double-sided boards. Open plated-through holes in double-sided boards may be repaired by insertion of a wire or flat ribbon through the hole, clinching it on both sides, or a funnel flanged eyelet. With soldered holes, solder must completely fill the hole and must form a fillet around the wire or eyelet on both sides of the board (see 3.5.3.2).

50.2.3.3.2 Multilayer boards. Open plated-through holes in multilayer boards shall not be repaired.

50.2.4 Measling and crazing. Repair is not permitted.

50.2.5 Holes and slots in boards. Repair is not permitted.

50.2.6 Internal circuits. Repair is not permitted.

50.2.7 Total maximum repairs permitted. The total maximum number of repairs of all types permitted per board shall be in accordance with table IV.

TABLE IV. Total number of repairs of all types permitted.

Board size (x)	Maximum number allowed
Square inches	
$x < 20$	6
$20 \leq x < 50$	12
$50 \leq x < 100$	18
$100 \leq x$	24

50.3 Cleanliness and resistivity of solvent extract (see 4.8.2).

50.3.1 Preparation of solvent extract test solution. Prepare a test solution of 75 percent by volume ACS reagent grade isopropyl alcohol and 25 percent by volume distilled/deionized water. Pass this solution through a mixed bed deionizer cartridge (Barnstead D8902, Ultra-Purse, Hose-Nipple Cartridge, or equal). After passage through the cartridge, typical resistivity of the solution will be 25×10^6 ohm-cm (conductivity - 0.04 micromho/cm). Replacement of the deionizer cartridge shall be required when the resistivity of the solution is of a value less than 6×10^6 ohm-cm (conductivity - greater than 0.166 micromho/cm) (see 50.3.4). Replacement of the solvent extract solution shall be required when the resistivity of the solution is of a value less than 2×10^6 ohm-cm (conductivity - greater than 0.50 micromho/cm) (see 40.5.1).

50.3.2 Preparation for test. Position a convenient sized polyethylene funnel over a suitable polyethylene container. Premark the container for the volume of test solution required for the test. Suspend the printed wiring assembly within the funnel.

50.3.3 Test procedure. Direct the test solution, in a fine stream, onto both sides of the assembly until 10 ml of test solution is collected for each square inch of assembly area. Assembly area includes the area of both sides of the board plus an estimate of the area of the components mounted thereon. Wash the assembly for a minimum of 1 minute. It is imperative that the initial washings be included in the test sample. Measure the resistivity/conductivity of the collected test solution with a conductivity bridge or other instrument of equivalent range and accuracy. NOTE: All laboratory ware must be scrupulously clean. Preferably, laboratory ware used for this test should be reserved for this test and not used elsewhere (see 50.3.4). Alternate test methods specified in 40.5.1 and 50.3.4.1 may be used.

50.3.4 Resistivity of solvent extract (see 4.8.2). This test procedure, including solution preparation and a laboratory ware cleaning procedure, is documented in Materials Research Report No. 3-72, "Printed wiring assemblies; detection of ionic contaminants on". Application for copies of this report should be addressed to the Commander, Naval Avionics Facility, Indianapolis, IN 46218.

50.3.4.1 Alternate methods. The following methods of determining the cleanliness of printed wiring assemblies have been shown to be equivalent to the resistivity of the solvent extract method in 50.3.4.

a. The Kenco Alloy and Chemical Company, Incorporated, "Omega Meter ™, Model 200".
b. Alpha Metals Incorporated, "Ionograph ™."
c. E. I. Dupont Company, Incorporated, "Ion Chaser ™."

Test procedures and calibration techniques for these methods are documented in Materials Research Report 3-78, "Review of Data Generated with Instruments Used to Detect and Measure Ionic Contaminants on Printed-Wiring Assemblies". Application for copies of this report should be addressed to the Commander, Naval Avionics Center, Indianapolis, IN 46218. Table V lists the equivalence factors for these methods in terms of microgram equivalents of sodium chloride per unit area:

TABLE V. Equivalence factors.

Method	$\bar{x}$ µgNaCl/in^2	Equivalence factor	Instrument "Acceptance limit" µgNaCl/Cm^2	Instrument "Acceptance limit" µgNaCl/in^2
MIL-P-28809-Beckman	7.47	$\frac{7.545}{7.545} = 1$	1.56	10.06
MIL-P-28809-Markson	7.62	$\frac{7.545}{7.545} = 1$	1.56	10.06
Omega Meter	10.51	$\frac{10.51}{7.545} = 1.39$	2.2	14
Ionograph	15.20	$\frac{15.20}{7.545} = 2.01$	3.1	20
Ion Chaser	24.50	$\frac{24.50}{7.545} = 3.25$	5.1	32

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