INCH-POUND
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SUPERSESSION NOTE
(SEE 6.2)

MILITARY STANDARD

STANDARD REQUIREMENTS FOR SOLDERED ELECTRICAL AND ELECTRONIC ASSEMBLIES

SOLD

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FOREWORD

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Code 5321, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. This proposed MIL-STD-2000 represents a reformatting of the DOD-STD-2000 series of soldering standards. All four elements of the DOD-STD-2000 series have been combined. We are continuing to use IPC-T-50 as the terms and definitions document. The structure of this new proposed document is:

- Baseline (these are the minimum requirements for all applications and are based on the requirements of DOD-STD-2000-4 (predominant) with some additions previously located in DOD-STD-2000-1 and DOD-STD-2000-3. The "level of difficulty" associated with these requirements has not been significantly raised from the prior DOD-STD-2000-4 level).

- Personnel Certification Option (these are the personnel training and certification requirements previously located in DOD-STD-2000-1).

- Printed Wiring Assembly Design Option (these are bare printed wiring requirements combined with the design and manufacturing process requirements of DOD-STD-2000-2).

- Process Control (General) Option (these are the majority of the process control requirements for the overall manufacturing process as previously specified by DOD-STD-2000-1 and DOD-STD-2000-3).

- Process Control (Hand Soldering) Option (these are the hand soldering process requirements formerly located in DOD-STD-2000-1).

- Process Control (Machine Processes) Option (these are the wave and reflow soldering process requirements formerly located in DOD-STD-2000-1).

4. To improve the overall tailorability of the document series, the baseline requirements have been located in section 4 (General Requirements) with the special options in section 5 (Detail Requirements). In this way the document meets the tailoring policy and guidelines of MIL-STD-962.

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

1. SCOPE

1.1 Scope. This standard establishes general requirements for materials and procedures for making soldered electrical and electronic connections. Soldered connections for leads and wires inserted in holes, surface mounted to lands, or attached to terminals shall be in accordance with this standard. In addition, component mounting requirements and acceptance criteria are provided to permit evaluation of complete assemblies. The manufacture of discrete devices, microcircuits, multichip microcircuits, and film microcircuits is outside the scope of this standard.

1.2 Applicability. When a contract, detail specification, or drawing requires MIL-STD-2000, the requirements of paragraph 4., General Requirements, and all subparagraphs shall be performed. The requirements of paragraph 5., Detail Requirements, are applicable only when a specific reference is made to the paragraph or one of tasks listed below. When an applicable requirement in 5. specifies a limit which differs from the corresponding limit in 4., the requirement in 5. shall take precedence. Where an applicable requirement in 5. is related to a requirement in 4. but does not specify superseding limits, the distinct but related elements of both requirements shall apply.

1.2.1 Task A: Certification of Contractor Personnel. When task A is required, 5.2 through 5.2.9.4 shall be performed.

1.2.2 Task B: Design and Component Mounting Requirements. When task B is required, 5.3 through 5.3.21.8 shall be performed.

1.2.3 Task C: General Process Controls. When task C is required, 5.4 through 5.4.21.19 shall be performed.

1.2.4 Task D: Hand Soldering Process Controls. When task D is required, 5.5 through 5.5.11.3.3 shall be performed.

1.2.5 Task E: Machine Soldering Process Controls. When task E is required, 5.6 through 5.6.7 shall be performed.

1.2.6 Task F: Process Control Manufacturing For Existing Designs. When task F is required, all requirements of tasks A, C, D, and E, contained in 5.2 through 5.2.9.4 and 5.4 through 5.6.7 shall be performed.

1.2.7 Task G: Controlled Process Manufacturing. When task G is required, all requirements of tasks A through F, contained in 5.2 through 5.6.7 shall be performed.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

O-E-760	Ethyl Alcohol (Ethanol) Denatured Alcohol, Proprietary Solvents and Special Industrial Solvents
O-M-232	Methanol (Methyl Alcohol)
QQ-N-290	Nickel Plating, Electrodeposited
QQ-S-571	Solder, Tin Alloy, Lead-Tin Alloy and Lead Alloy
TT-B-848	Butyl Alcohol, Secondary, For Use in Organic Coatings
TT-I-735	Isopropyl Alcohol

MILITARY

MIL-I-7444	Insulation Sleeving, Electrical Flexible
MIL-F-14256	Flux, Soldering, Liquid (Rosin Base)
MIL-I-22076	Insulation Tubing, Electrical Nonrigid, Vinyl, Very Low Temperature Grade
MIL-E-22118	Enamel, Electrical, Insulating
MIL-I-23053	Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for
MIL-P-28809	Printed Wiring Assemblies
MIL-G-45204	Gold Plating, Electrode Deposited
MIL-C-45224	Cable and Harness Assemblies, Electrical, Missile System, General Specification for
MIL-I-46058	Insulating Compound, Electrical for Coating Printed Circuit Assemblies
MIL-P-50884	Printed Wiring, Flexible and Rigid-Flex
MIL-P-55110	Printed Wiring Boards
MIL-R-55342	Resistor, Fixed, Film, Chip, Established Reliability, General Specification for
MIL-C-55365/4	Capacitor, Chip, Fixed, Tantalum, Established Reliability, General Specification for
MIL-C-81302	Cleaning Compound, Solvent, Trichlorotrifluoroethane

SPECIFICATIONS (continued)

MILITARY (continued)

MIL-T-81533	Trichloroethane 1, 1, 1 (Methyl Chloroform) Inhibited, Vapor Degreasing
MIL-P-81728	Plating, Tin Lead, Electrodeposited
MIL-S-83519	Splice, Shield Termination, Solder Style, Insulation, Heat Shrinkable, Environment Resistant, General Specification for
MIL-C-85447	Cleaning Compounds, Electrical and Electronic Components

STANDARDS

FEDERAL

FED-STD-376	Preferred Metric Units for General Use by the Federal Government

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-883	Test Methods and Procedures for Microelectronics
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically-Initiated Explosive Devices) (Metric)
DOD-STD-1866	Soldering Process, General (Non-Electrical) (Metric)
MIL-STD-2118	Flexible and Rigid-Flex Printed Wiring for Electronic Equipment, Design Requirements for
MS21266	Grommet, Plastic, Edging

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Naval Publications and Forms Center (Attn: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

ANSI/IPC-T-50	Terms and Definitions for Interconnecting and Packaging Electronic Circuits
IPC-SM-840	Printed Board, Permanent, Polymer Coating (Solder Mask) for Qualification and Performance of

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 7380 North Lincoln Avenue, Lincolnwood, IL 60646.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3295	Polytetrafluoroethylene Tubing

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

CFR, Title 29, Part 1900 to 1919, Chapter XVII	Code of Federal Regulations, Occupational Safety and Health Administration, Department of Labor

(Application for copies should be addressed to the American Conference of Industrial Hygienists, 6500 Glenway, Building D-7, Cincinnati, OH 45211.)

Industrial Ventilations, Manual of Recommended Practices

(Application for copies should be addressed to: Committee of Industrial Ventilation, P.O. Box 16153, Lansing, MI 48902.)

2.3 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. DEFINITIONS

3.1 Terms and definitions. The definitions applicable to this standard shall be in accordance with ANSI/IPC-T-50.

4. GENERAL REQUIREMENTS

4.1 Interrelation of applicable documents.

4.1.1 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

4.1.2 Conflict. In the event of any conflict between the requirements of this standard and the applicable assembly drawing(s), the government approved applicable assembly drawing(s) shall govern. In the event of conflict between the requirements of this standard and an assembly drawing that has not been approved by the government, differences shall be referred to the designated government activity for approval. Upon such approval, the provisions shall be officially documented (by notice of revision or equivalent) on the assembly drawing(s) which shall then govern.

4.1.3 Existing designs. The requirements of this standard shall not constitute the sole cause for redesign if the design has been approved. However, when drawings for such existing designs undergo revision for any reason, they shall be reviewed and changes made that allow for maximum practical compliance with the requirements of this standard.

4.2 Visual aids. Line drawings, illustrations and photographs depicted herein and any additional provisions approved by the procuring Government Contracting Officer are provided as aids for determining compliance with the written requirements of this standard and shall not take precedence over the written requirements.

4.3 Nonelectrical soldered connections. Soldered connections utilized to join surfaces in nonelectrical applications shall be in accordance with DOD-STD-1866.

4.4 Solderability. The solderability of parts shall meet the requirements of:

a. MIL-STD-750 Method 2026 for semiconductors,

b. MIL-STD-883 Method 2003 for microelectronics,

c. MIL-P-55110 for rigid printed wiring boards,

d. MIL-P-50884 for flexible and rigid-flex printed wiring boards, and

e. MIL-STD-202 Method 208 for all other parts not covered by (a) through (d) above.

4.5 Printed wiring. Rigid printed wiring shall be designed to MIL-STD-275 and built in accordance with MIL-P-55110. Flexible and rigid-flex printed wiring shall be designed to MIL-STD-2118 and built in accordance with MIL-P-50884. When used, blind and buried vias shall be incorporated in all test coupons.

4.6 Solder mask. Dry film polymer mask shall be applied by a vacuum laminant process. Polymer solder mask coatings and temporary maskants shall also be of a material that:

a. Does not degrade the substrate material or printed wiring;

b. Precludes solder flow to the masked area;

c. Is compatible, if left in place, with printed wiring board basis material, solder, printed wiring, and subsequently applied conformal coatings; and

d. If temporary, can be readily removed without post-removal residual contamination harmful to board integrity.

4.7 Markings and designators. Markings and designators shall be in accordance with Requirement 67 of MIL-STD-454.

4.8 Electrostatic discharge. Electrostatic discharge control for the protection of electrical and electronic parts, components, assemblies and equipment shall be in accordance with MIL-STD-1686.

4.9 Facilities, tools and equipment.

4.9.1 The soldering facility.

4.9.1.1 Cleanliness. Work areas and tools shall be maintained in a clean and orderly condition. There shall be no visible dirt, grime, grease, flux, or solder splatter, nor other contaminating foreign materials at any work station. Eating, smoking, or drinking at a work station shall be prohibited. Handcreams, ointments, perfumes, cosmetics, and other materials unessential to the fabrication operation are also prohibited at the work station.

4.9.1.2 Lighting. Illumination at the working surface of soldering stations shall be 100 foot-candles minimum (1077 Lm/m^2).

4.9.2 Soldering and related tools.

4.9.2.1 Tool selection. Tools shall be suitable for the purpose intended and shall not cause damage to the parts, boards, or solder connections. The following tools are considered suitable for their application.

4.9.2.2 Steel wool. Steel wool shall not be used.

4.9.2.3 Mechanical strippers. Mechanical strippers utilized to remove insulation from stranded or solid conductor wires may be of the hand operated or automatic high volume machine type. Hand operated strippers shall be of a fixed die configuration (see figure 1). Automatic high volume machine strippers shall be of a type utilizing either fixed dies, dies adjustable to calibrated stops, or roller cutters adjustable to calibrated stops. Dies, whether adjustable or fixed, shall be properly maintained to assure consistently sharp and even cuts without damage to the wires or unstripped insulation.

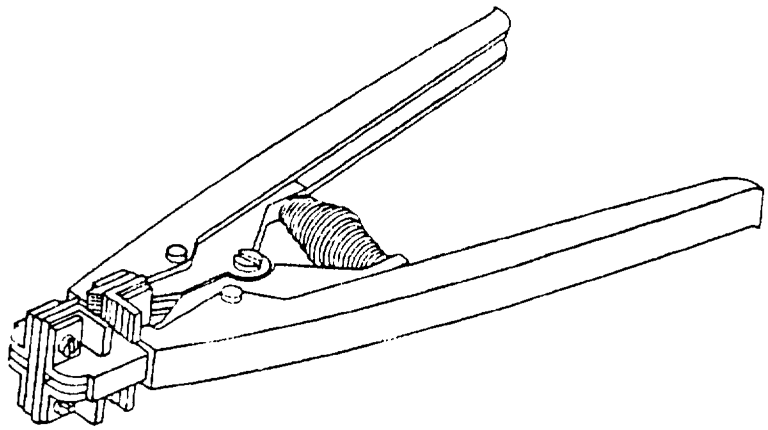


FIGURE 1. Mechanical hand wire stripper (see 4.9.2.3).

4.9.2.4 Chemical strippers. Chemical solutions, pastes, and creams used to strip hookup and magnet wires shall be suitable for removal of the insulation to be stripped and shall be limited to those that:

a. Cause no degradation of the base metal of the wire.

b. Allow wires or conductors to be neutralized and cleaned of both ionic and nonionic contaminants.

4.9.2.5 Thermal strippers. Thermal strippers utilized to remove insulation from stranded and solid conductor wires shall be of a type that can be regulated to provide the required temperature. Temperature controls shall be sufficient to prevent damage to the wire or unstripped insulation.

4.9.2.6 Solder for thermal solder stripping. If applicable, thermal solder stripping of solder strippable magnet wire (with polyurethane or similar insulation) may be performed by hot solder application in compliance with the wire manufacturer's recommendations.

4.9.2.7 Holding devices. Tools, fixtures, and materials used to hold or restrain wires and components shall be of a design which will not damage or deform the wires, leads, wire insulation, or components. If toothed clips are utilized, the jaws of the clips shall be covered to provide the required protection.

4.9.2.8 Bending tools. Bending tools used for wire or lead bending may be automatic or hand implements and shall be of a material that will not cut, nick, or otherwise damage solid or stranded wires, leads, integral insulation, or any other insulation or insulators added prior to the bending operation. Bending tools shall be of a type that imparts no damage to the component bodies or seals.

4.9.2.9 Automatic lead forming devices. Automatic lead forming devices are acceptable. Smooth impression marks (base metal not exposed) resulting from bending tool holding forces shall not be cause for rejection.

4.9.2.10 Clinching tools. Clinching tools or clinching devices shall be of such design and shall be made of a material which will not cause damage to printed wiring boards, printed circuitry, and component leads or components mounted thereon.

4.9.2.11 Wire and lead cutting tools. Tools used to cut leads of semiconductor devices and other shock-sensitive components shall not damage the components. Shear-type cutters or holding fixtures to absorb the shock may be used. Diagonal, side, or end cutting tools may be used to cut wire or leads of components which are not sensitive to mechanical shock. The combination of a cutting and forming tool may be used provided the tools meet these requirements and the leads, after cutting, meet all inspection criteria specified herein.

4.9.2.12 Heat source. Devices used for shrinking heat shrinkable tubing shall be temperature controlled to prevent damage to components, wiring, or boards.

4.9.2.13 Thermal shunts. Thermal shunts shall be of such material, size, shape, and design as to permit rapid application and removal with minimum interference to the soldering procedure and to facilitate rapid heat dissipation from the area being soldered.

4.9.3 Soldering equipment.

4.9.3.1 Soldering irons. Soldering irons and resistance heating elements shall be selected to meet the electrostatic discharge requirements of 4.8 and shall heat the connection area rapidly and maintain proper soldering temperature at the connection througnout the soldering operation.

4.9.3.2 Soldering iron holders. A soldering iron holder shall be of a type satisfactory for the soldering iron utilized. The holder shall leave the soldering iron element and tip unsupported without applied excess physical stress or heat sinking and shall protect personnel from burns.

4.9.3.3 Wiping pads. Sponge pads for wipe cleaning the soldering iron tip shall be finely textured and sulphur free.

4.9.3.4 Soldering guns. Soldering guns of the transformer type shall not be used.

4.9.3.5 Solder pots. Solder pots shall be capable of maintaining the solder temperature at 500 $\pm$ 10°F (260 $\pm$ 5.5°C). Solder pots shall be grounded.

4.9.3.6 Machine soldering systems. Machine soldering systems shall be of the automatic or automated type of such design to provide:

a. A capability for preheating printed wiring assemblies.

b. The capacity to maintain the solder temperature at the printed wiring assembly within ±10°F (±5.5°C) of the established bath temperature throughout the span of any continuous soldering run.

c. An exhaust system, either integral or separate, adequate to assure conformance with applicable OSHA health and safety requirements.

4.9.3.7 Carriers. Devices used for the transport of printed boards through preheat, soldering, and cooling stages shall be of such material, design, and configuration that they shall not contaminate, mar, or otherwise damage the printed board. Carriers shall not transmit vibrational or shock stress from the conveyors or other such mechanisms to cause board, part, or component degradation and shall also be of such design to prevent electrostatic discharge damage to components.

4.10 Materials. Materials used in the soldering processes stipulated in this standard shall be as specified herein. The materials and processes specified herein may be incompatible in some combinations. The manufacturer is responsible for selecting those materials and processes that will produce acceptable products.

4.10.1 Solder. Solder composition Sn60, Sn62, or Sn63, solder form optional, conforming to QQ-S-571 shall be used. Sn5, Sn10, or Sn96 solder, conforming to QQ-S-571, may be used for high temperature soldering when specified on the government approved assembly drawing. The flux of cored solder shall be type R or RMA. Core conditions and flux percentages are optional.

4.10.2 Flux. Rosin based fluxes conforming to types R or RMA of MIL-F-14256 shall be used for making soldered connections. The flux used in solder (wicking) braid shall be type R or RMA. Rosin base flux conforming to Type RA of MIL-F-14256 may be used for tinning component leads of sealed devices, solid bus wire, and terminals provided that:

a. The tinning process is performed in a closed area isolated from fabrication or production areas;

b. The contractor maintains controls to prevent distribution or use of Type RA flux outside the prescribed tinning area and the Type RA flux is not stored in uncontrolled storage areas; and

c. Items processed are not returned to production or fabrication processes until all residues have been removed. The Government may review flux removal procedures, processes, and processing. If at any time flux residue is detectable after these processes are completed, the use of RA flux shall be suspended until acceptable corrective action is implemented.

4.10.3 Solder creams (paste) and solder preforms. Solder creams (paste) and solder preforms shall meet the requirements of 4.10.1 and 4.10.2. Flux solvents used in solder creams (paste) shall not be harmful to the work piece or solder joint and shall be easily removed after the soldering operation.

4.10.4 Solvents and cleaners. The solvents or aqueous cleaners used for removal of grease, oil, dirt, flux, and other debris, shall be selected for their ability to remove both ionic and non-ionic contamination. The solvents or cleaners used shall not degrade the materials or parts being cleaned. A list of approved solvents and cleaners is provided in tables I and II. If other solvents and cleaners are used, analysis and documentation demonstrating compliance with the above requirements shall be available for review and disapproval. Mixtures of the approved solvents may be used.

TABLE I. Solvents.

Solvent	Specification
Ethyl Alcohol	O-E-760, Types III, IV or V
Isopropyl Alcohol	TT-I-735
Methyl Alcohol (see 4.10.4.3)	O-M-232, Grade A
Butyl Alcohol, Secondary (see 4.10.4.3)	TT-B-848
1, 1, 1-Trichloroethane (see NOTE)	MIL-T-81533
Trichlorotrifluoroethane (see 4.10.4.1 and 4.10.4.2)	MIL-C-81302
Trichlorotrifluoroethane (see 4.10.4.1 and 4.10.4.2)	MIL-C-85447, Type II
Solvent Petroleum Distillate (Stoddard) (see 4.10.4.4)	Use Appendix B

TABLE II. Cleaners.

Cleaners	Specification/Note
Water	1 megohm-cm, minimum resistivity
Detergent cleaners and saponifiers	Subject to review and disapproval

NOTE: 1, 1, 1-Trichloroethane may attack plastics commonly used in electronic assemblies, including acrylics and polycarbonates and may also attack rubber, neoprene and silicone. Use of this solvent should be restricted or carefully controlled. (Do not mix with water.)

4.10.4.1 Solvents in which a nitromethane stabilizer is blended with trichlorotrifluoroethane conforming to either MIL-C-81302 or MIL-C-85447 (Type II) are also acceptable provided such mixtures are preblended by the supplier.

4.10.4.2 Trichlorotrifluoroethane blends which include ketones or halocarbons other than chlorofluorocarbons defined in MIL-C-81302 or MIL-C-85447 (Type II) are unacceptable. Mixtures of trichlorotrifluoroethane and water shall not be used.

4.10.4.3 Methyl alcohol and secondary butyl alcohol shall be used only when purchased as a constituent of an already blended solvent. Pure methyl alcohol or secondary butyl alcohol shall not be used alone as a solvent.

4.10.4.4 Solvent in accordance with Appendix A shall be used only as a constituent of an already blended solvent. The pure solvent shall not be used unblended. The blended solvent shall not be used as a final cleaner.

4.11 Preparation for soldering.

4.11.1 Cleanliness. The cleanliness of terminals, component leads, conductors, and printed wiring surfaces shall be sufficient to ensure solderability. When required, the surfaces shall be cleaned by either chemical methods or tinning. Cleaning shall not damage the component, component leads, or conductors. Knives, emery cloth, sandpaper, sandblasting, braid, erasers, and other abrasives shall not be used. Cleaning may be as follows:

a. Grease and oil shall be removed from conductors and terminals by applying a noncorrosive solvent such as: 1, 1, 1-trichloroethane conforming to MIL-T-81533; ethyl alcohol conforming to O-E-760, type III or isopropyl alcohol conforming to TT-I-735.

b. Oxides and varnishes shall be removed by methods which do not damage leads or parts, and which do not cause contamination or hinder solder wetting.

c. Dust or other loose matter shall be removed.

NOTE: When chemical compounds are used, caution should be exercised to protect personnel from toxic vapors that are emitted.

4.11.2 Stripping insulation. Sufficient insulation shall be stripped from the wire or leads to provide for insulation clearances as specified in 4.11.4.4. In stripping insulation, care should be taken to avoid nicking or otherwise damaging the wire or the remaining insulation. The number of damaged or severed strands in a single wire shall not exceed the limits given in table III. Wires used at a potential of 6kV or greater shall have no broken strands. Insulation discoloration resulting from thermal stripping is permissible.

TABLE III. Limits.

Number of strands	Maximum allowable nicked or broken strands
Less than 7	0
7-15	1
16-18	2
19-25	3
26-36	4
37-40	5
41 or more	6

NOTE: When performance of task C (see 1.2.3) is required, no broken strands are allowed.

4.11.3 Tinning. At the time of soldering, component leads and terminations not meeting the designated solderability requirements shall be reworked by tinning or other methods as defined in paragraph 4.11.1. Where tinning is used, electroplated tin-lead shall be in accordance with MIL-P-81728 and hot dip solder tinning shall provide a minimum solder thickness of 0.0001 inch (0.0025 mm) on the surface of round leads and the crest of flat leads. Tinning of a stranded wire shall not obscure the wire contour at the termination end of the insulation to permit inspection of the wire for damage. Heat sinks shall be applied to leads of heat sensitive parts during the tinning operation. The preconditioning solder pot shall be maintained in accordance with 4.13.4.1 and 4.13.4.2. Wicking of solder under the insulation of stranded wire shall be minimized. Solder shall not obscure the contour of the conductor at the termination of the insulation. The leads of all devices to be planar mounted shall be tinned prior to installation.

4.11.4 Attachment of wires and axial-leaded component leads. Unless otherwise specified herein attachment of wires and leads to terminals and to printed boards shall be in accordance with MIL-STD-275 for rigid printed wiring boards and MIL-STD-2118 for flex and rigid-flex printed wiring boards. Other attachments of wires and leads shall meet the requirements of the following paragraphs.

4.11.4.1 Wire and lead wrap around. Leads and wires shall be mechanically secured to their terminals before soldering. Such mechanical securing shall prevent motion between the parts of a connection during the soldering operation. Leads and wires shall be wrapped around terminals for a minimum of one-half and not more than three fourths turn (see figure 2). For AWG size 30 or smaller wire, a minimum of one turn and a maximum of 3 turns shall be used. Exception is made in the case of those small parts used for terminating conductors and to which such mechanical securing would be impracticable, such as connector solder cups, slotted terminal posts and heat shrinkable solder devices. Lead extension shall be restricted to the limits required by design to prevent equipment malfunction. In no case shall wires and leads be wrapped on or atop each other. In addition, the requirements of MIL-STD-454, Requirement 17, shall apply.

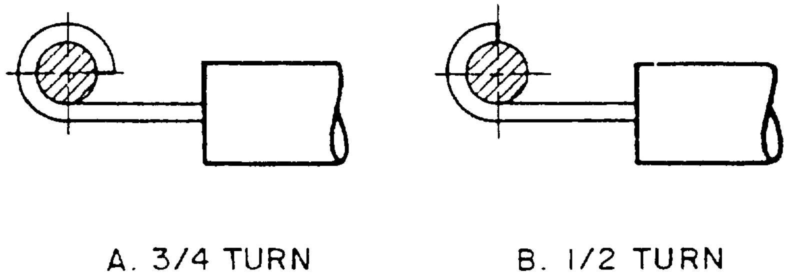


FIGURE 2. Wire and lead wrap around (see 4.14.4.1).

4.11.4.2 Lead bends. For parts other than planar mounted devices the distance between the body of the part or weld and the bent section of a lead shall be at least twice the diameter of the lead but not less than 0.030 inch (0.76 mm). The radius of bends shall conform to table IV and figure 3. Planar mounted device lead forming requirements are located in paragraphs 4.11.5 thru 4.11.5.9.

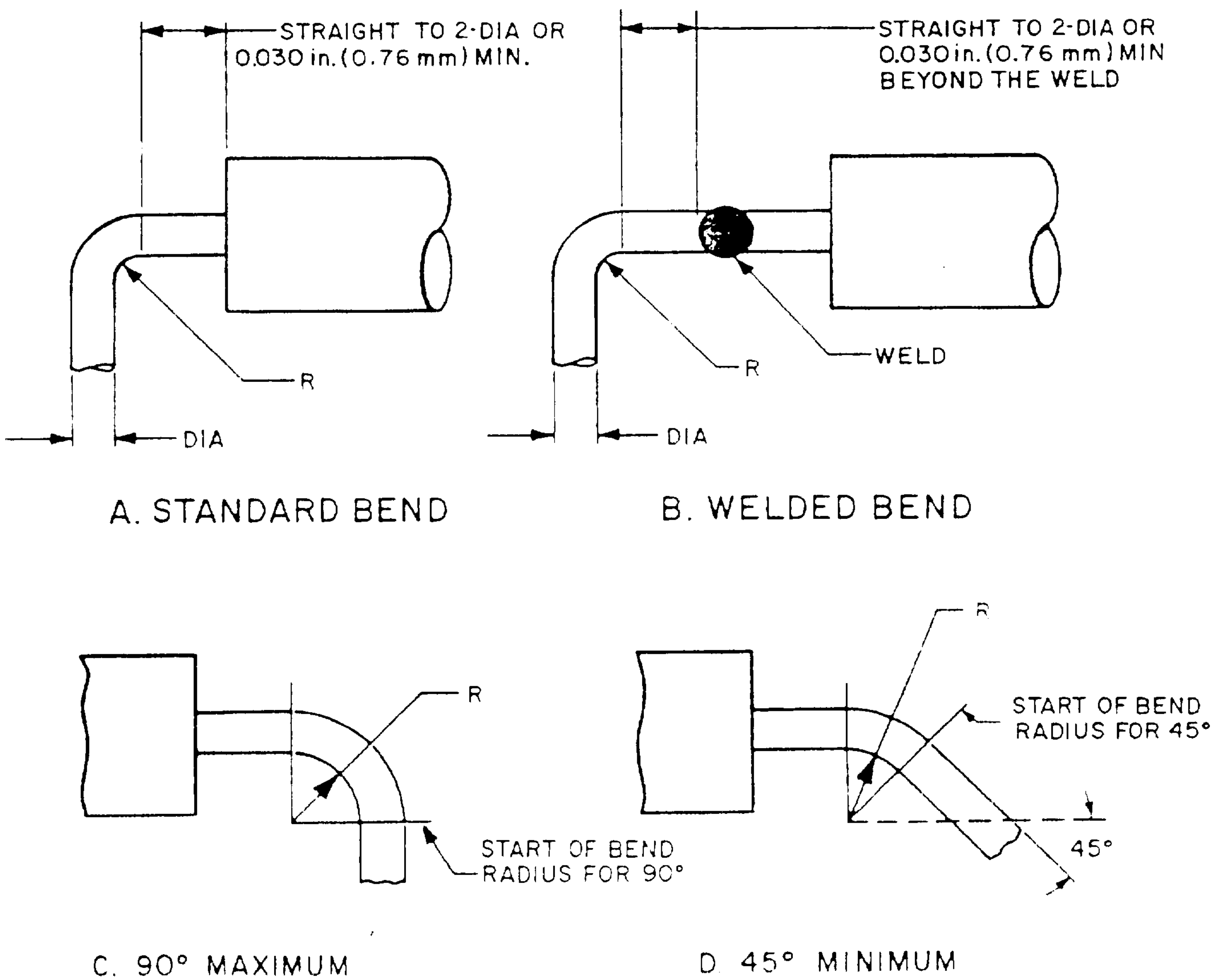


FIGURE 3. Lead bend (see 4.14.4.2).

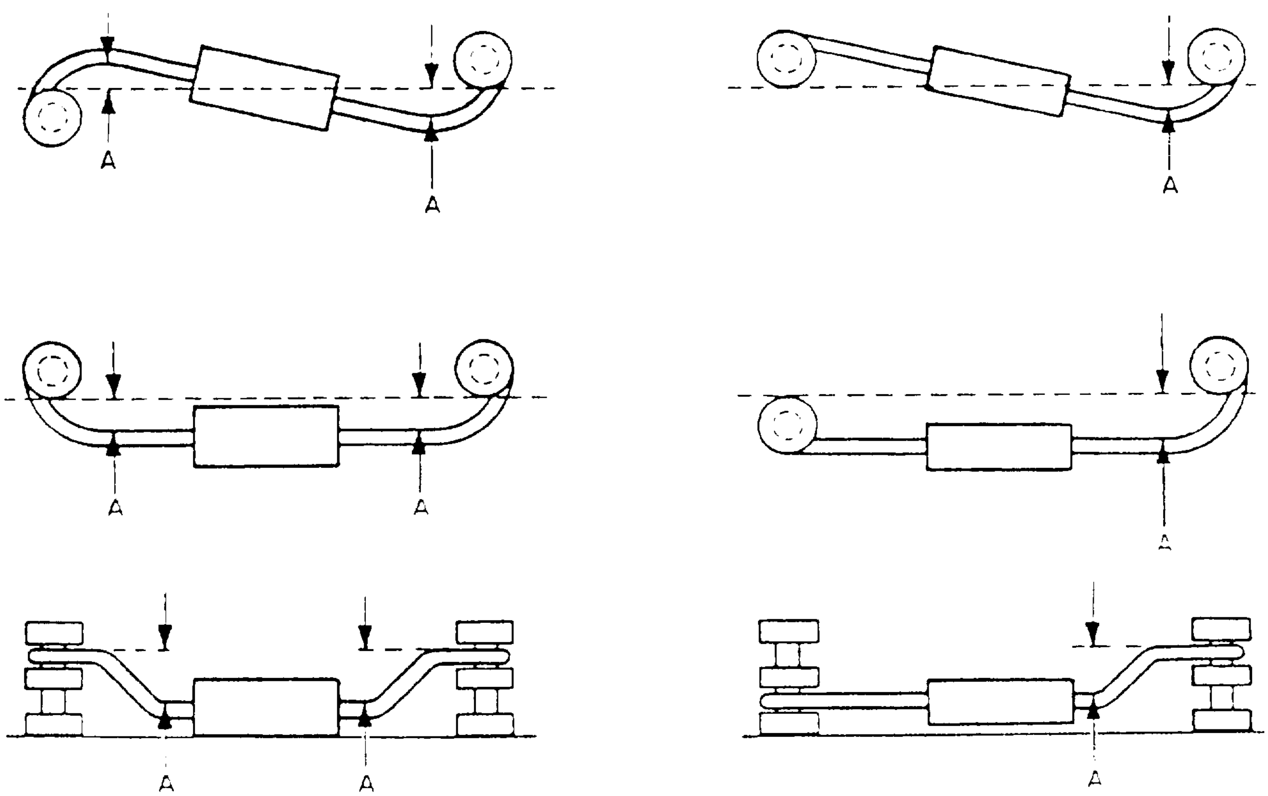
TABLE IV. Bend radii.

Lead diameter (inch)	Minimum radius (R) (inch)
Up to 0.027 inch (0.69 mm)	1 diameter
From 0.028 to 0.047 inch (0.71 to 1.19 mm)	1.5 diameter
0.048 inch (1.22 mm) and larger	2 diameter

4.11.4.3 Stress relief. Axial or opposed lead devices with leads terminating at a connection point shall have a minimum lead-connection-to-body offset of at least 2 lead diameters or thicknesses, but not less than 0.030 inch (0.76 mm), as an allowance for stress relief to minimize tensile or shear stress to the soldered connection or part during thermal expansion. Where the component body will not be secured to the mounting surface by bonding, coating, or other means, the lead(s) on only one of the opposing sides of the component need be so configured. Typical examples of stress relief are included in figure 4.

Devices with bodies either secured or unsecured to the mounting surface

Alternate method for devices with bodies unsecured to the mounting surface



Measurement "A" is equal to or greater than two times lead diameter or thickness but not less than 0.030 inch (0.76 mm).

FIGURE 4. Typical stress relief bends (see 4.11.4.3).

4.11.4.4 Insulation clearance. Clearance between the solder of the connection and the end of either separable or fixed insulation on the wire in the connection shall be as follows:

a. Minimum clearance. There shall be visible clearance between the insulation and solder connection. The insulation shall not abut the solder, nor shall it be embedded in, nor surrounded by the solder. Neither shall the insulation be melted, charred, seared, nor diminished in diameter.

b. Maximum clearance. Clearance shall be less than two wire diameters (including insulation) or 1/16 inch (1.58 mm), whichever is larger, but shall not be such that it permits shorting between adjacent conductors.

c. High voltage clearance: The insulation clearance for high voltage wires (thick walled insulation) shall be 1/8 ± 1/16 inch (3.18 ± 1.58 mm) unless otherwise specified in the assembly drawing.

4.11.5 Planar mounted device lead forming.

4.11.5.1 Planar mounted device lead bends. Leads shall be supported during forming to protect the lead-to-body seal. Bends shall not extend into the seal. The lead shall extend a minimum of 0.015 inch (0.38 mm) from the body before being bent. Lead bend radius shall be 1-1/2 thicknesses (1.5) or 1-1/2 wire diameters (1.5) minimum. The angle of that part of the lead between the upper and lower bends in relation to the mounting pad shall be 45° minimum to 90° maximum (see figure 5).

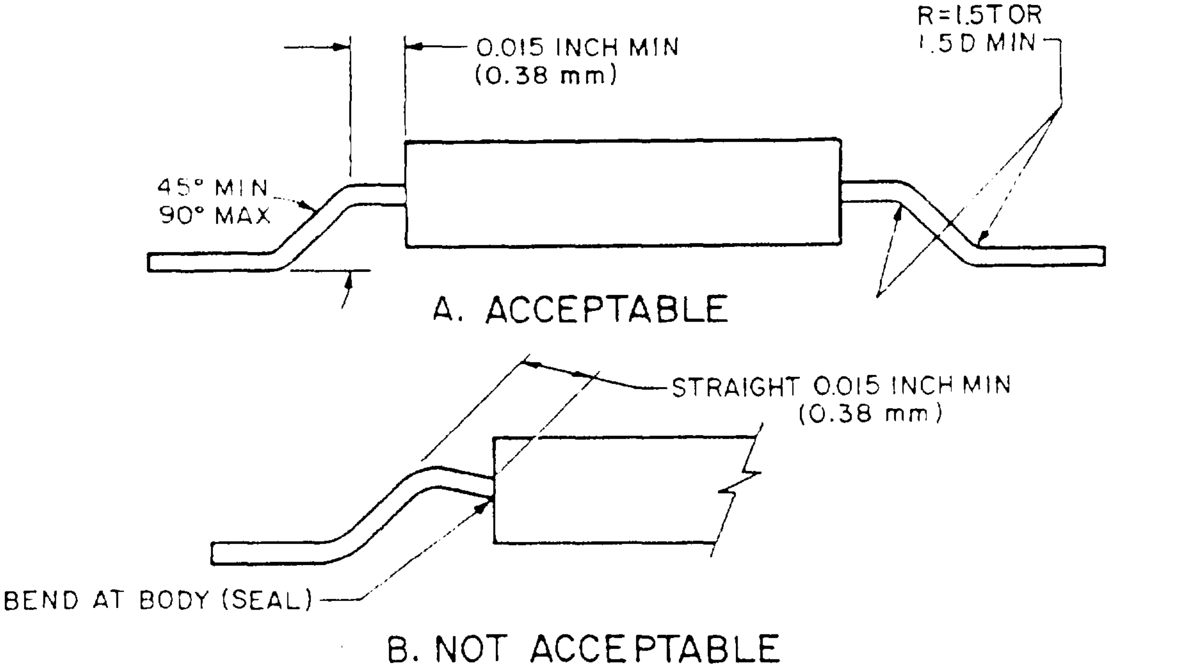


FIGURE 5. Planar mounted device lead forming (see 4.11.5.1).

4.11.5.2 Planar mounted device lead forming over circuitry. Parts mounted over protected surfaces, or surfaces without exposed circuitry, may be mounted flush. Parts mounted over exposed circuitry shall have their leads formed to allow a minimum of .010 inch (0.25 mm) between the bottom of the component body and the exposed circuitry (see figure 6).

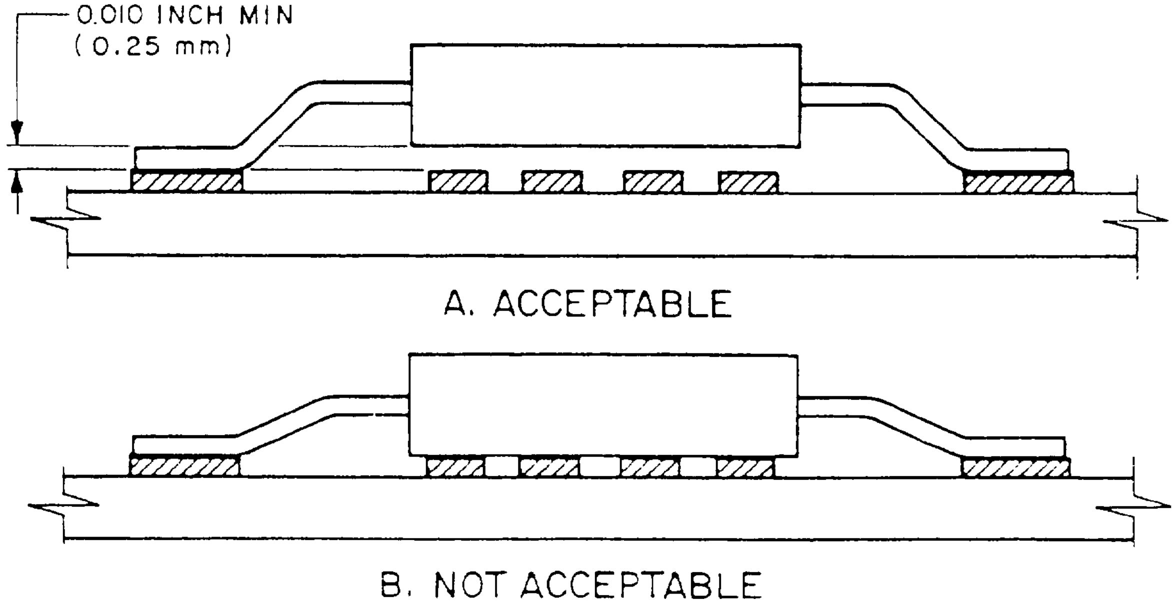


FIGURE 6. Planar mounted device lead forming over circuitry (see 4.11.5.2).

4.11.5.3 Planar mounted device lead deformation. Minor lead deformation shall be allowed, provided none of the following conditions exist (see figure 7):

a. No evidence of a short or potential short exists.
b. Lead or body is not damaged by the deformation.
c. Top of lead does not extend beyond the top of body. Preformed stress loops may extend above the top of the body.
d. Toe curl, if present on bends, shall not exceed two times the thickness (2T).

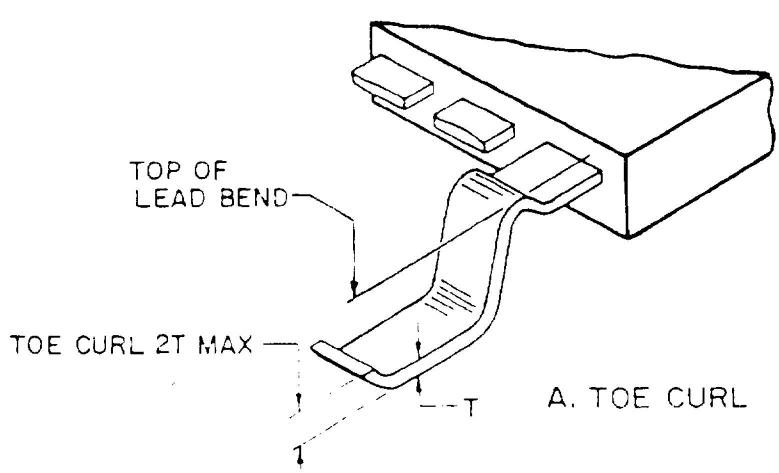


FIGURE 7. Planar mounted device lead deformation (see 4.11.5.3).

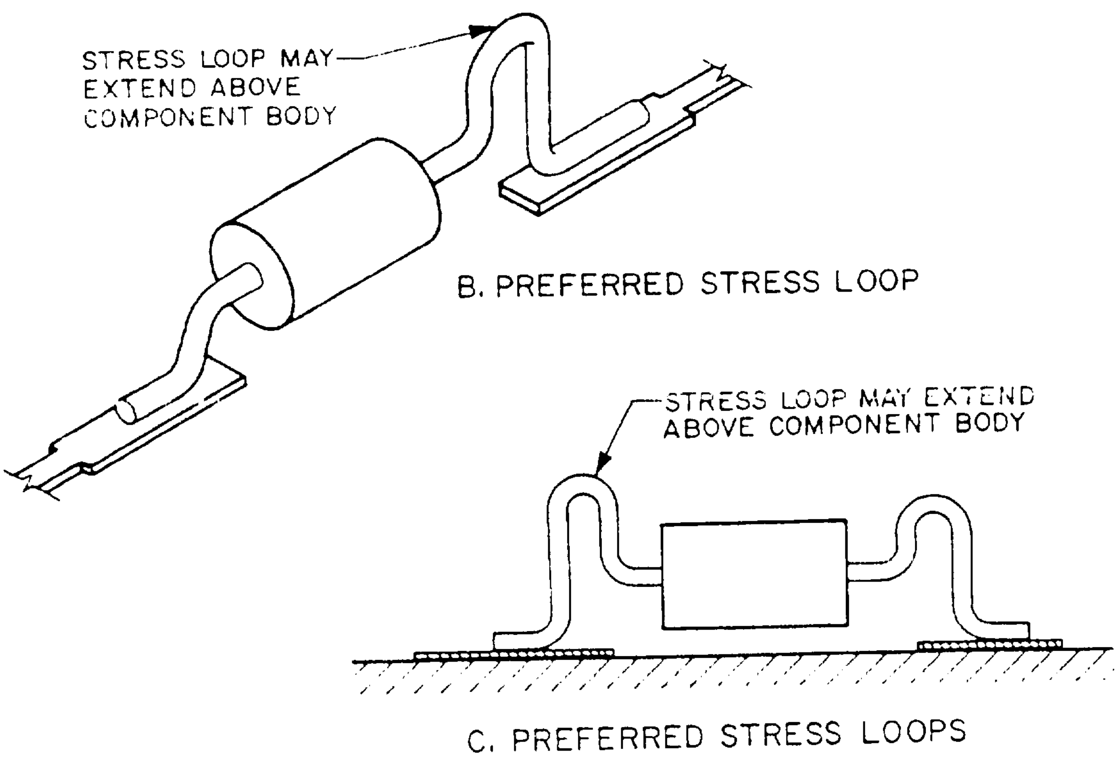


FIGURE 7. Planar mounted device lead deformation (see 4.11.5.3) (continued).

4.11.5.4 Planar mounted device lead and land contact. Minimum contact length shall be equal to the lead width for flat leads and two times the diameter (2D) for round leads (see figure 8).

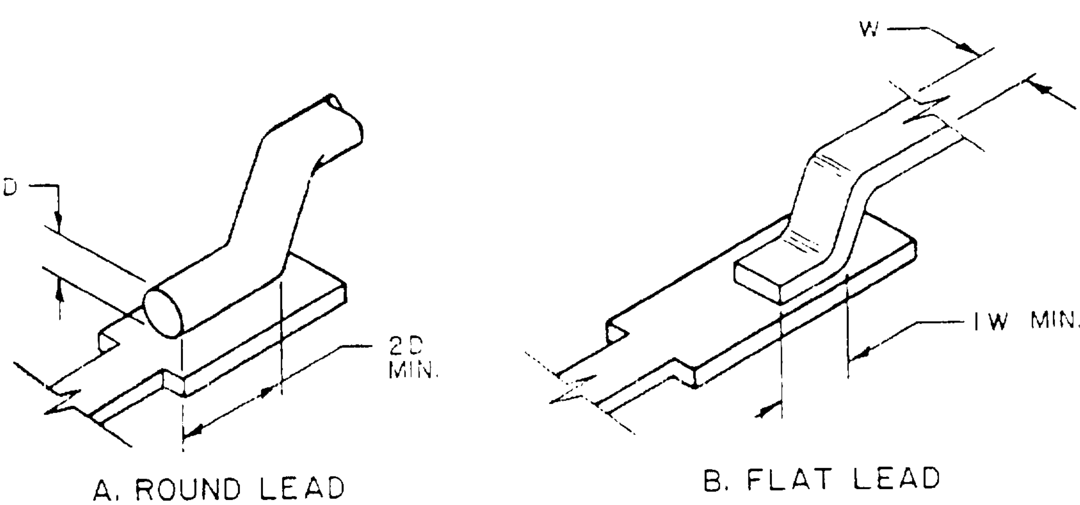


FIGURE 8. Planar mounted device lead and land contact (see 4.11.5.4).

4.11.5.5 Planar mounted device flat lead overhang. Flat leads may have side overhang, provided the overhang does not exceed 25 percent of the lead width or 0.020 inch (0.5 mm), whichever is less, and minimum conductor spacing is maintained (see figure 9).

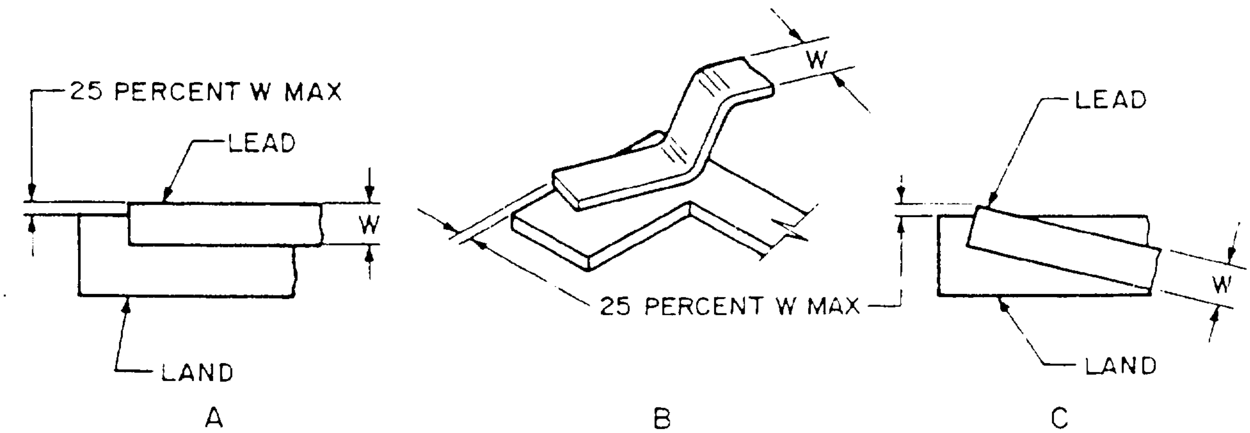


FIGURE 9. Planar mounted device flat lead overhang (see 4.11.5.5).

4.11.5.6 Planar mounted device round or coined lead side overhang. Round, flatted, or coined leads of planar mounted devices shall not exhibit any side overhang. Skewing is permissible provided there is no side overhang (see figure 10).

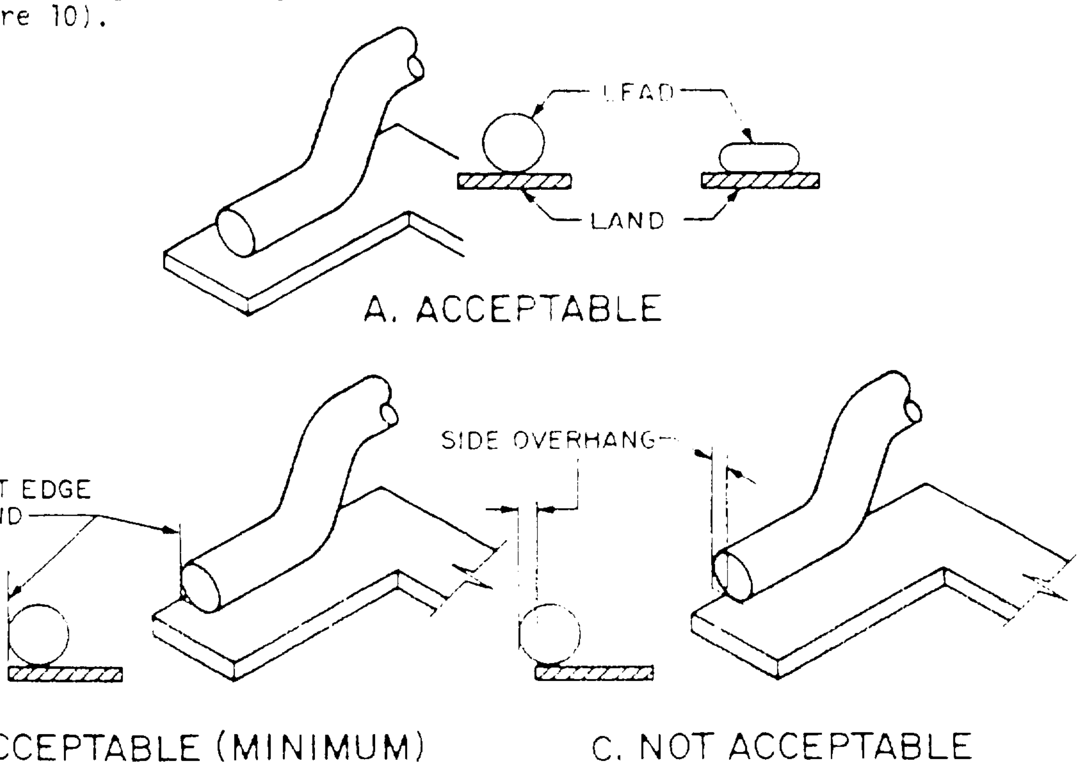


FIGURE 10. Planar mounted device round or coined lead side overhang (see 4.11.5.6).

4.11.5.7 Planar mounted device lead toe overhang. Toe end of leads of planar mounted devices may overhang the land, provided the minimum conductor spacing is maintained, the total overhang does not exceed 25 percent of the lead width or diameter (round leads) or 0.020 inch (0.5 mm), whichever is less, and the minimum contact length is maintained (see figure 11).

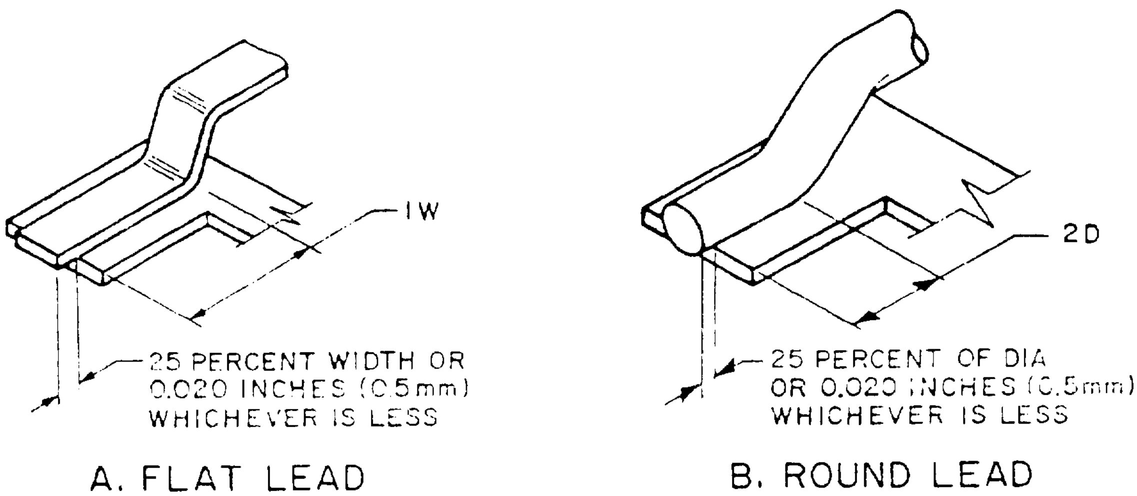


FIGURE 11. Planar mounted device lead toe overhang (see 4.11.5.7).

4.11.5.8 Planar mounted device lead heel clearance. Round and flat leads shall be placed so that the heel shall be a minimum of 2D or 1W from the edge of the land (see figure 12).

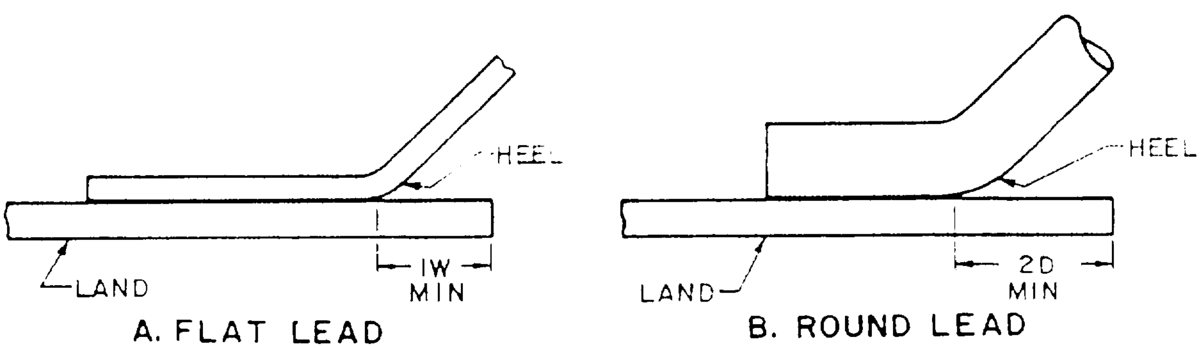


FIGURE 12. Planar mounted device lead heel clearance (see 4.11.5.8).

4.11.5.9 Planar mounted device lead height off land. Round or coined leads may be raised off the land surface a maximum of one-half of the original lead diameter. Flat or ribbon leads may be raised off the land surface a maximum of two times the lead thickness or 0.020 inches (0.5 mm), whichever is less (see figure 13). Toe up or toe down on flat and round leads shall be permissible provided that separation between leads and termination area does not exceed 2T and 1/2D limits.

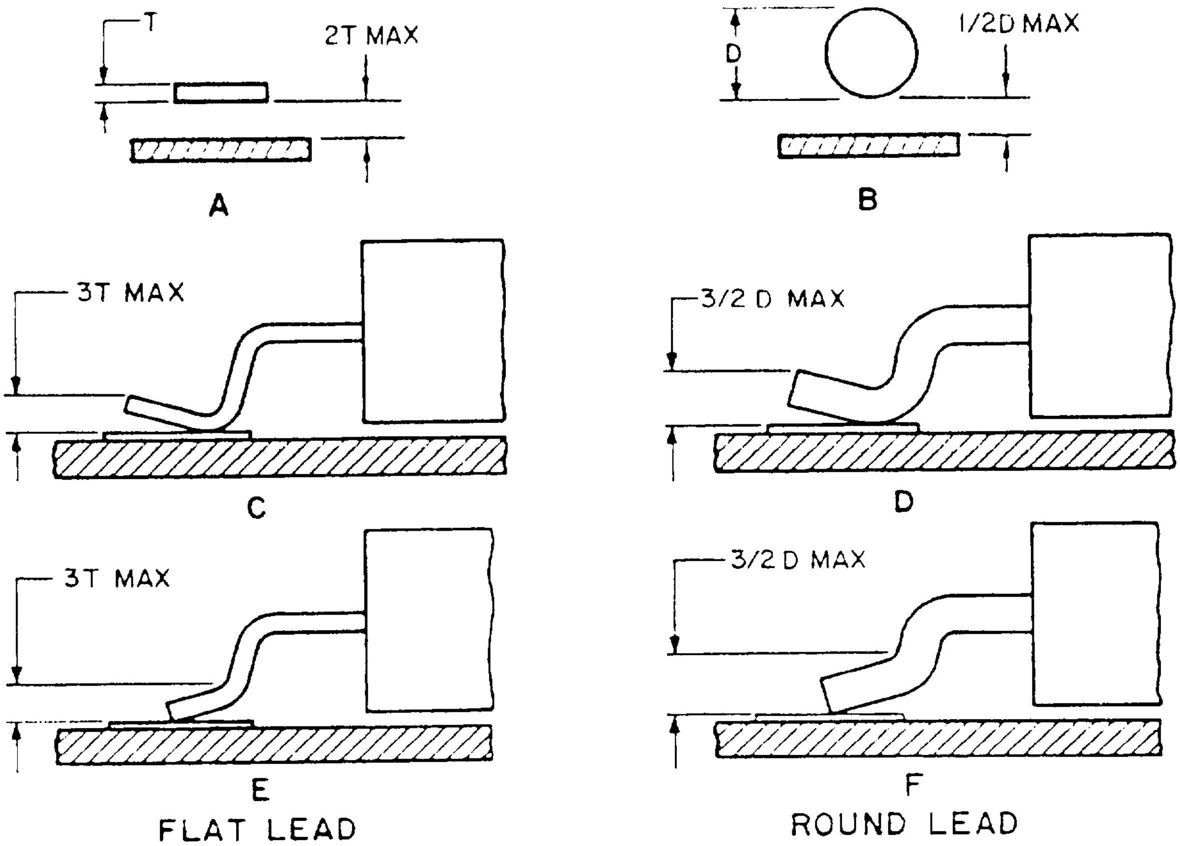


FIGURE 13. Planar mounted device lead height off land (see 4.11.5.9).

4.11.6 Surface mounted devices. Unless otherwise specified herein, the mounting and soldering of leadless chip carriers, J-leaded devices and other surface mounted devices shall be in accordance with MIL-STD-275.

4.12 Manual soldering.

4.12.1 Applying flux. When used, liquid flux shall be applied in a thin, even coat to those surfaces being joined prior to application of heat. Cored solder wire shall be placed in such a position that the flux can flow and cover the connection as the solder melts. Flux shall be applied such that no damage will occur to surrounding parts and materials.

4.12.2 Applying heat. The areas to be joined shall be heated to cause melting of the solder and wetting of the surfaces. Excessive time (slow heating) and excessive temperature shall be avoided to prevent unreliable connections and damage to parts. Heat sinks shall be used as required for the protection of parts. Parts, wire insulation or printed wiring boards which have been charred, melted, or burned shall be replaced. When heat has caused part materials to discolor, further evaluation shall be performed to ascertain whether the essential properties have been adversely affected; if so, the item shall be replaced.

4.12.3 Applying solder. The areas to be joined shall be heated to the correct temperature, then the solder shall be applied to the connection and not the soldering iron; however, a very small quantity of solder may be applied at the place where the iron tip touches the connection to improve heat transfer. When solder preform or solder paste methods are used, the solder shall be applied to the connection prior to heating.

4.13 Wave soldering for printed wiring assemblies.

4.13.1 Board condition. Prior to soldering, the assembly shall be adequately dried.

4.13.2 Flux application. Liquid flux shall be applied by the dip, spray, brush, roll, wave, or foam method and shall form a thin coating on the surface. The flux shall be thinned as necessary to meet the requirements of flux application; however, the flux shall still meet the requirements of 4.10.2. The flux shall be dried to a tacky consistency before wave soldering to prevent solder splatter.

4.13.3 Preheating. Printed wiring assemblies shall be preheated prior to soldering. The preheat temperature shall not exceed the maximum temperature rating of parts.

4.13.4 Solder bath. The solder bath shall be maintained at a temperature of 450°F to 550°F (232°C to 288°C). The period of exposure of any printed wiring board to a solder bath shall be limited to a duration which will not cause damage to the board or parts mounted thereon. In no case shall the temperature or length of time be such as to cause damage to heat sensitive parts. Periodic inspections of the solder bath shall be made to insure that contamination levels meet the requirements of 4.13.4.1b.

NOTE: The temperature and the time of contact between the assembly and the solder is dependent upon such factors as preheating, thickness of board, number of contacts or conductors, and the type of parts.

4.13.4.1 Maintenance of solder purity. Solder purity shall be maintained as follows:

a. Before soldering a printed wiring board, all dross appearing on the surface shall be removed. Stainless steel or polytetrafluoroethylene (TFE) shall be used for stirring solder and removing dross. Dross blankets may be used provided the blankets do not contaminate the solder.

b. If the amount of any individual contaminant or if the total of contaminants listed exceeds the percentages specified in table V, the solder shall be replaced or altered to be brought within specifications.

4.13.4.2 Inspection for solder purity. Solder in solder baths shall be chemically or spectrographically analyzed or renewed at the testing frequency levels shown in table V, column B. These intervals may be lengthened to the eight hour operating days shown in column C, when the results of analyses provide definite indications that such action will not adversely affect the purity of the solder bath. If contamination exceeds the limits of table V, intervals between analyses shall be shortened to those eight hour operating days shown in column A or less until continued purity has been assured by analyses. Records containing the results of all analyses and solder bath usage shall be available for Government review.

4.13.4.2.1 Guidelines. The information provided in the right hand column of table V is a guideline for monitoring of the soldering operation and may be used to indicate a need for increased frequency of testing, other than that shown in columns A, B and C, to ensure proper purity levels.

4.13.5 Touchup. Manual soldering as specified herein is permitted, if necessary, to remove solder projections, icicles, and bridges of solder, or to add solder to the part connection area. The quality standards for touchup shall be the same as for the original work.

4.14 Hold down of planar mounted device leads. Except for lead compression during resistance reflow soldering, planar mounted device leads shall not be held down under stress during solder solidification.

4.15 Cooling. No liquid shall be used to cool a soldered connection. The connection shall be cooled at room temperature only. Heat sinks may be used to expedite cooling. The connection shall not be subjected to movement or stress at any time during the cooling and solidification of the solder.

4.16 Rework. The reworked connection shall conform to the requirements for the original connection. A cold solder or disturbed connection may require only reheating and reflowing of the solder.

4.17 Post soldering cleaning. Residues shall be removed within one hour after soldering by applying approved noncorrosive solvents as specified in table I and drying. Mechanical means such as agitation or brushing may be used in conjunction with the solvents. The cleaning solvents and methods used shall have no deleterious effect on the parts, connections, and materials being cleaned. Ultrasonic cleaning shall not be used for cleaning electrical or electronic assemblies or components or parts that contain electronic components. After cleaning, there shall be no visible evidence of flux residue or other contamination when examined in accordance with paragraph 4.19.1.

4.18 Cleanliness testing. Periodic testing of ionic cleanliness of the product of each cleaning system, except interim cleaning (at the workstation), shall be conducted on a random sample basis to ensure contamination limits have not been exceeded. The resistivity of solvent extract test, or the sodium chloride (NaCl) salt equivalent ionic contamination test, or an equivalent test which is fully documented and available for review and disapproval by the government shall be used to test for ionic cleanliness. The restivity of solvent extract test shall have a final value greater than 2 megohm-centimeters. The sodium chloride salt equivalent ionic contamination test shall have a final value less than 10.0 micrograms per square inch of board surface area.

TABLE V. Contamination limits.

Contaminant 1/	Maximum Contamination Limits Percent by Weight		Interval Between Testing 8 Hr Operating Day 3/			Solder Joint Characteristic Guidelines (If Solder is Contaminated) 4/
	Preconditioning (Lead/Wire Tinning)	Assy Soldering 2/ (Pot, Wave, Etc.)	A	B	C	
Copper	.75	.30	15	30	30	Sluggish solder flow, solder hard and brittle
Gold	.50	.20	15	30	30	Solder grainy and brittle
Cadmium	.01	.005	15	30	60	Porous and brittle solder joint, sluggish solder flow
Zinc	.008	.005	15	30	60	Solder rough and grainy, frosty and porous High dendritic structure
Aluminum	.008	.006	15	30	60	Solder sluggish, frosty and porous
Antimony	.20 → .50	.20 → .50	15	60	120	Not enough: Solder crumbles into white powder after low temperature aging Too much: Solder brittle
Iron	.02	.02	15	60	120	Iron tin compound $FeSn_2$ is not solderable Compound on surface presents resoldering problems.
Arsenic	.03	.03	15	60	120	Small blister-like spots
Bismuth	.25	.25	15	60	120	Reduction in working temperature
Silver 5/	.75	.10	15	60	120	Dull appearance - retards natural solvent action
Nickel	.025	.01	15	60	120	Blisters, formation of hard insoluble compounds

1/ The tin content of the solder bath shall be within the limits of QQ-S-571 for the solder specified and tested at the same frequency as testing for copper/gold contamination. The balance of the bath shall be lead and/or the items listed above.

2/ The total of copper, gold, cadmium, zinc and aluminum contaminants shall not exceed .4% for assembly soldering.

3/ An operating day constitutes any 8-hour period, or any portion thereof, during which the solder is liquefied and used.

4/ See paragraph 4.13.4.2.

5/ Not applicable for Sn62 solder - limits to be 1.75 → 2.25 (both operations).

4.18.1 Resistivity of solvent extract. Solvent extract resistivity shall be as follows:

a. Prepare a test solution of 75 +0/-2 percent by volume of reagent grade isopropyl alcohol, with the remainder being deionized water. Pass this solution through a mixed bed deionizer cartridge. After passage through the cartridge, the sensitivity of the solution shall be greater than 6 megohm-centimeters (conductivity less than 0.166 micromhos/cm).

b. Clean a funnel, a bottle, and a container with a portion of this test solution. Measure 10 milliliters of fresh test solution for each square inch of assembly area into the wash bottle. Assembly area includes the areas of both sides of the board.

c. Slowly, direct the test solution, in a fine stream, onto both sides of the assembly until all of the measured solution has been used.

d. Collect the rinse solution and measure per 4.18.

4.18.2 Sodium chloride salt equivalent ionic contamination test. Sodium chloride salt equivalent ionic contamination shall be measured as follows:

a. The sodium chloride salt equivalent ionic contamination test shall use a solution of 75 +0/-2 percent by volume of reagent grade of isopropyl alcohol with the remainder being deionized water. The solution shall be verified for correct composition upon initial use and every four hours during a shift. The time limit may be extended with objective record reviews and concurrence by the local CAS organization.

b. The equipment must be validated using a known amount of sodium chloride standard on the same schedule as the percentage composition verification.

c. The starting, or reference, purity of the solution shall be greater than 20,000,000 ohm-centimeters (0.05 micromhos/centimeter) before each sample is tested.

TABLE VI. Cleanliness test values.

Test method	Starting resistivity	Ending value
Solvent Extract Resistivity	6×10^6 ohm-cm	Shall be greater than 2×10^6 ohm-cm
Sodium Chloride Salt Equivalent Ionic Contamination	20×10^6 ohm-cm	Shall be less than 10.0 micrograms/square inch

4.18.3 Alternate methods. The following equipment and associated methods of determining the cleanliness of printed wiring assemblies have been shown to be equivalent to the resistivity of the solvent extract method in paragraph 4.18.1.

a. The Kenco Alloy and Chemical Company, Inc., "Omega Meter™, Model 200."

b. Alpha Metals, Inc. "Ionograph™."

c. E. I. Dupont Company, Inc. "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 VII lists the equivalence factors for these methods in terms of microgram equivalents of sodium chloride per unit area.

TABLE VII. Equivalence factors for testing ionic contamination.

Method	$\bar{X}$ μgNaCl/in^2	Equivalence factor	Instrument "Acceptance limit"	
			μgNaCl/Cm^2	μgNaCl/in^2
MIL-P-28809-Beckman	7.47 7.545	$\frac{7.545}{7.545} = 1$	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

NOTE: 4.18.3 and table VII are not intended to preclude use of other compatible equipment and equivalence values.

4.19 Workmanship. Workmanship shall be of a level of quality adequate to assure that the processed products meet the performance requirements of the engineering drawings and criteria delineated herein. Kovar or other iron based alloys leads shall be covered with solder. The cutting of component leads or wires after soldering shall be followed by the reflow of the solder connection.

4.19.1 Inspection. Visual inspection of all soldered connections and assemblies shall be performed at a minimum magnification of 3 diopters (approximately 1.75X at a focal length of 10 inches (254 mm)) with a light source providing a shadowless illumination of the area being viewed. Statistical sampling may be used in lieu of 100% inspection when done as part of a process control system approved by the procuring activity. To determine conformance to the requirements specified herein, 10X shall be used for referee examinations.

4.19.2 Finish. The appearance of the solder joint surface shall be smooth, nonporous, noncrystalline, bright, and continuous. Solder joints having a gray appearance are not acceptable, except that those made with high temperature solder or if one or more connection elements are gold plated, the surface may appear slightly porous and grayed rather than bright.

4.19.2.1 Overheated connection. There shall be no overheated connections.

4.19.2.2 Cold connection. There shall be no cold connections.

4.19.2.3 Flow line. A nonuniform flow line, where the solder fillet blends to a surface being joined, is acceptable provided good wetting is evident.

4.19.2.4 Probe marks. Probe marks in solder connections shall not be in a location nor of a size, shape, or number which causes degradation of connection elements or solder integrity. When probe points are provided for solder connections on printed wiring boards in accordance with MIL-STD-275, probe marks shall be restricted to such points.

4.19.3 Physical attributes. The solder connection shall be free of scratches, sharp edges, spikes, pin holes, blow holes, flux residue, inclusions of foreign material, pits, and voids so located or of a size and shape that connection integrity is degraded. Solder shall not appear as globules, peaks, strings, and bridging between adjacent conductor paths.

4.19.3.1 Rosin connection. There shall be no rosin connections.

4.19.3.2 Fractures. There shall be no split, crack, fracture, or separation within the solder or between the solder and connection elements.

4.19.3.3 Splits. There shall be no crack, separation, or split in the barrel of the plated-through hole nor any at either hole knee (the interface between the barrel and the terminal area).

4.19.4 Coverage. Solder shall be of sufficient amount to cover all elements of the connection but shall not be of such quantity that the outline of any included lead or lead wire is not discernible in the solder. Neither insufficient nor excessive solder (see 4.19.9.4 and 4.19.9.5) shall be acceptable. In the case of stranded wires, the outlines of the strands shall be discernible.

4.19.4.1 Acceptable amount of solder on plated-through hole or unsupported hole. For leads or wires protruding through plated-through or unsupported holes, the length of the lead or wire shall be covered with solder, but if the lead or wire end is covered, the end shall be discernible. Solder connections shall cover at least 80 percent of the land and shall not overhang the land. There shall be no solder bridges or protrusions. Solder shall cover at least 80 percent of the land surface and the full 360° arc of the hole (see figure 14).

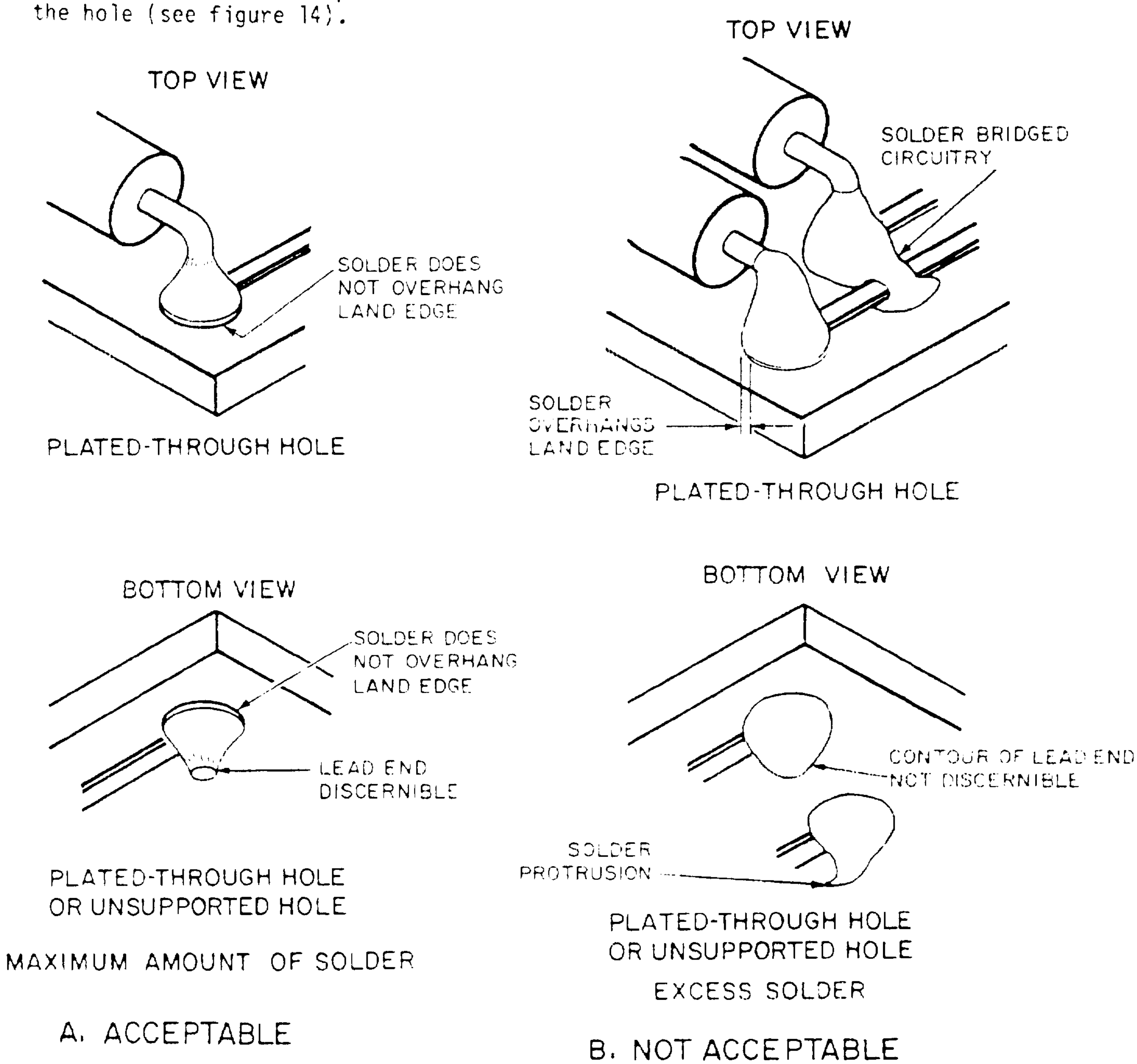


FIGURE 14. Maximum amount of solder (see 4.19.4.1).

4.19.4.2 Minimum amount of solder on plated-through holes. For plated through holes with leads or wires inserted therein, total combined top and bottom solder recession shall be no more than 25 percent of the total thickness of the board including land on both sides. A concave fillet shall wet the upper edge of the complete 360° arc of the hole. The lower land shall also be wetted over the full 360° arc and at least 80 percent of the land shall be covered with solder (see figure 15).

4.19.4.3 Minimum amount of solder on unsupported hole. All lands of unsupported holes with leads or wires inserted therein shall be wetted over the full 360° arc and the full area of the lands shall be covered with solder (see figure 15).

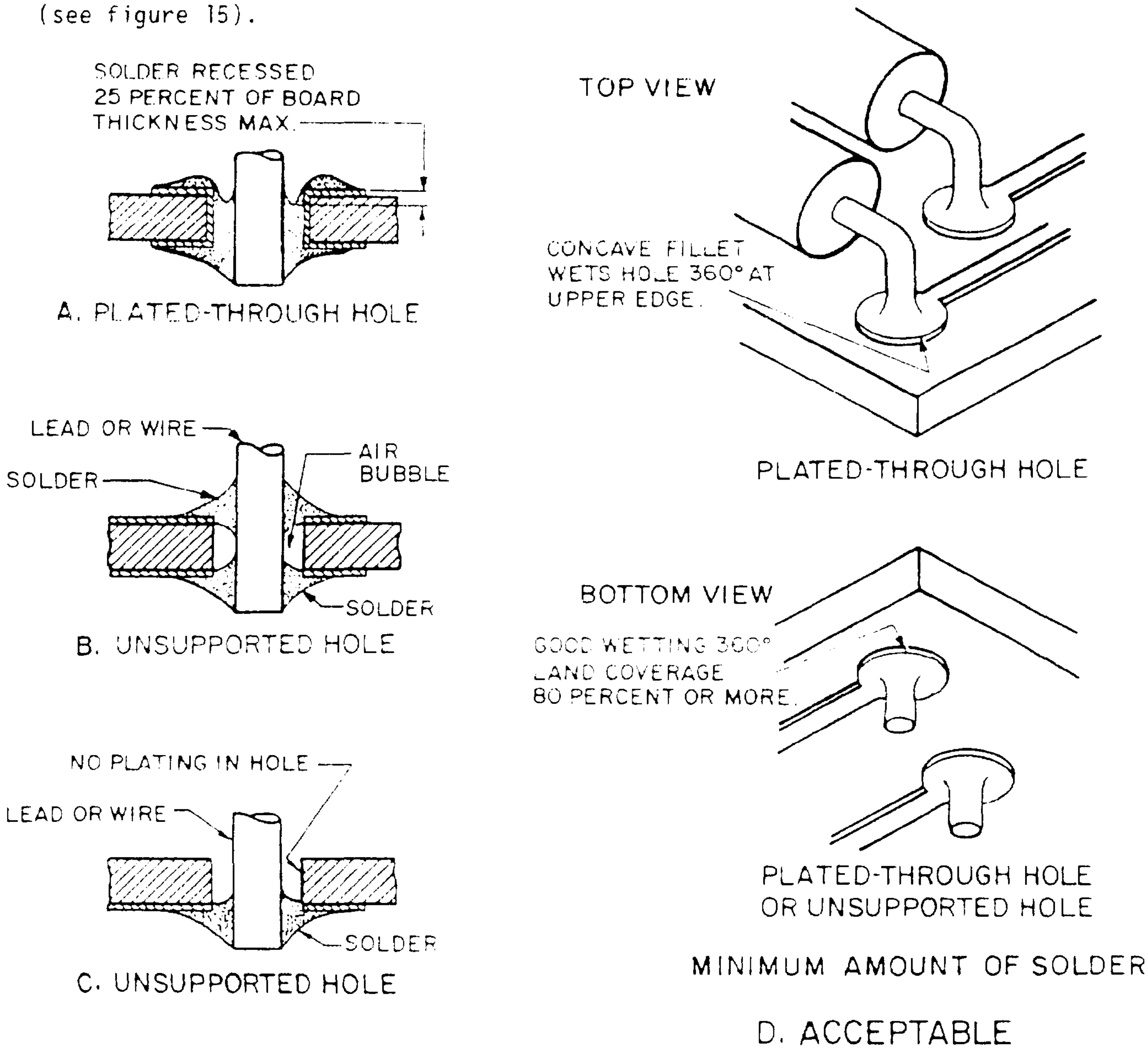
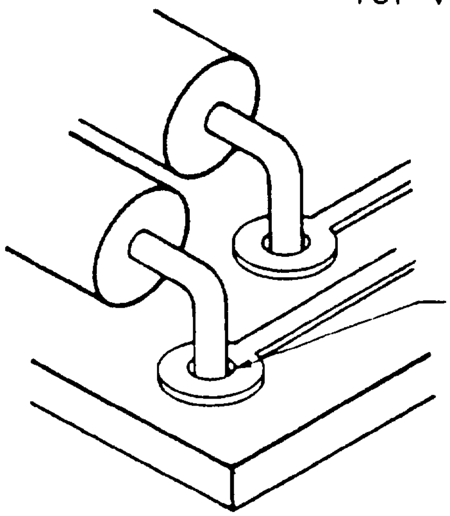


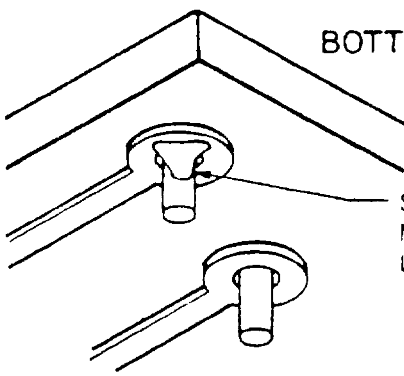
FIGURE 15. Minimum amount of solder (see 4.19.4.2 and 4.19.4.3).

TOP VIEW



PLATED-THROUGH HOLE

BOTTOM VIEW



PLATED-THROUGH HOLE
OR UNSUPPORTED HOLE

INSUFFICIENT SOLDER

E. NOT ACCEPTABLE

FIGURE 15. Minimum amount of solder (see 4.19.4.2 and 4.19.4.3) (continued).

4.19.5 Wetting and filleting. Solder shall wet the surfaces of all connection elements and form a fillet between elements over the complete periphery of the connection. The solder shall have a small contact angle between the surfaces being joined. A small inclusion in the fillet does not constitute dewetting. Solder shall not gather in droplets or balls (see figure 16).

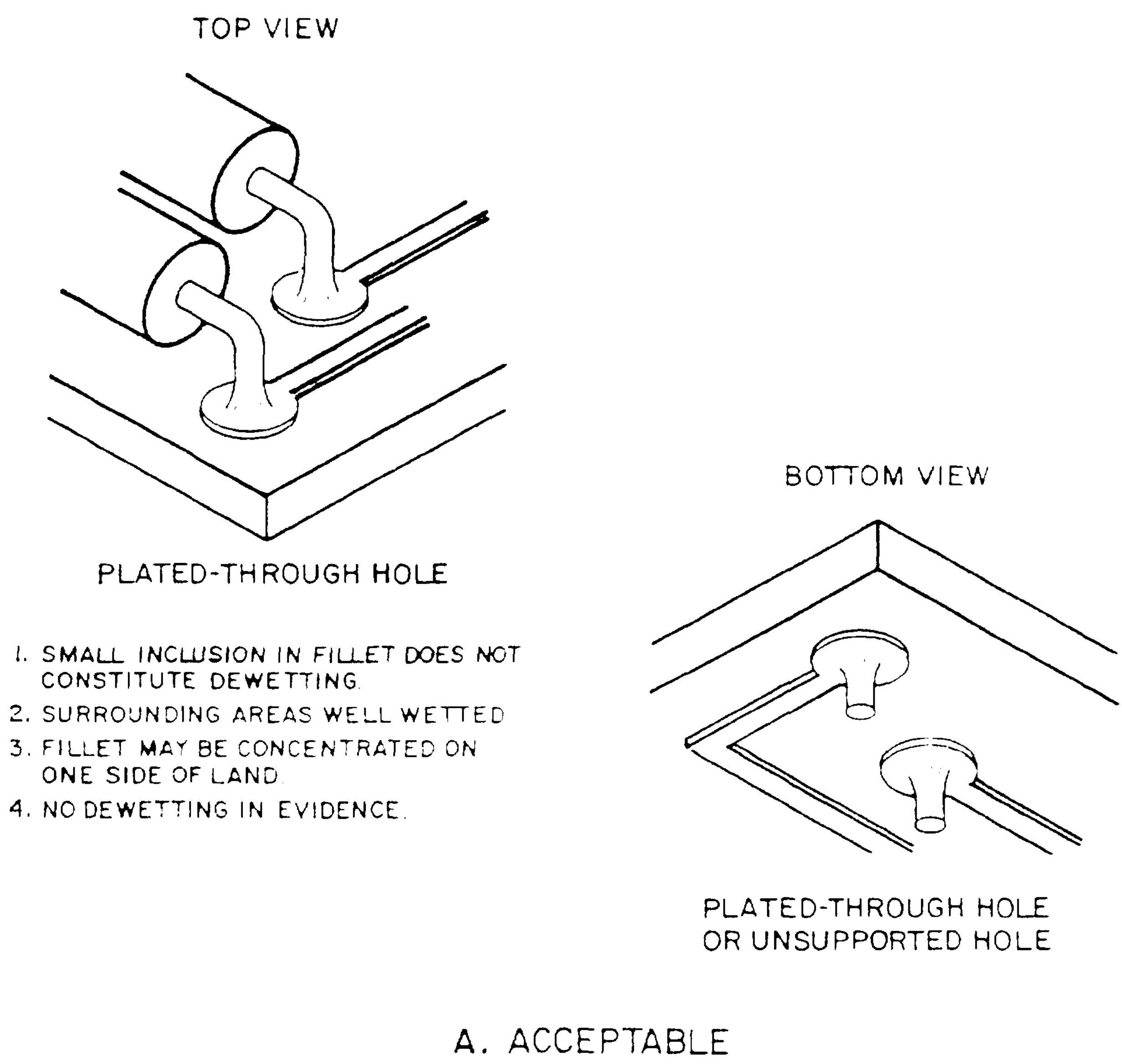
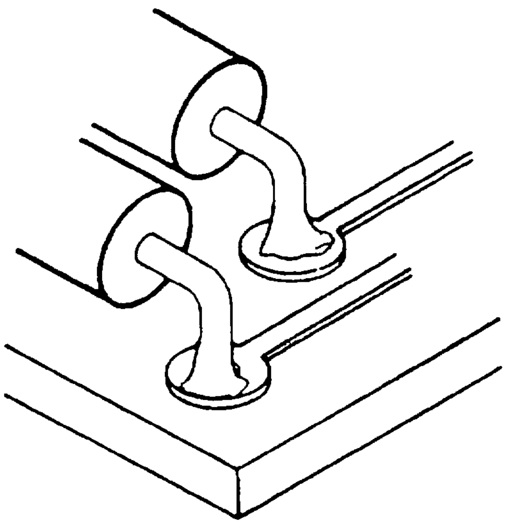


FIGURE 16. Plated-through holes straight-through lead-solder wetting (see 4.19.5).

TOP VIEW

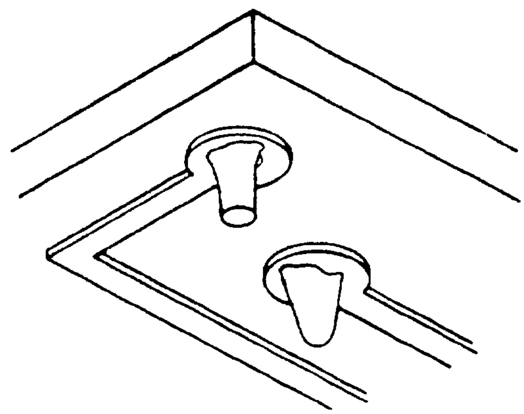


PLATED-THROUGH HOLE

1. SOLDER DOES NOT COMPLETELY COVER SURFACES OR DOES NOT FEATHER TO LEAD OR LAND SURFACES.

2. SOLDER GATHERS INTO DROPLETS OR BALLS.

BOTTOM VIEW



PLATED-THROUGH HOLE OR UNSUPPORTED HOLE

B. NOT ACCEPTABLE

FIGURE 16. Plated-through holes straight-through lead-solder wetting (see 4.19.5) (continued).

4.19.5.1 Dewetting and nonwetting. There shall be no solder dewetting or nonwetting in excess of 5% of the lead periphery.

4.19.5.2 Visual characteristics of acceptable solder connections. Solder shall wet the surfaces of all connection elements and shall form a fillet between connection elements over the complete periphery of the connection. The solder shall have a small contact angle between the surfaces being joined. As a minimum, solder shall fill a plated-through hole 75 percent of the board thickness. A nonplated through hole need not be covered with solder (see figures 17 and 18).

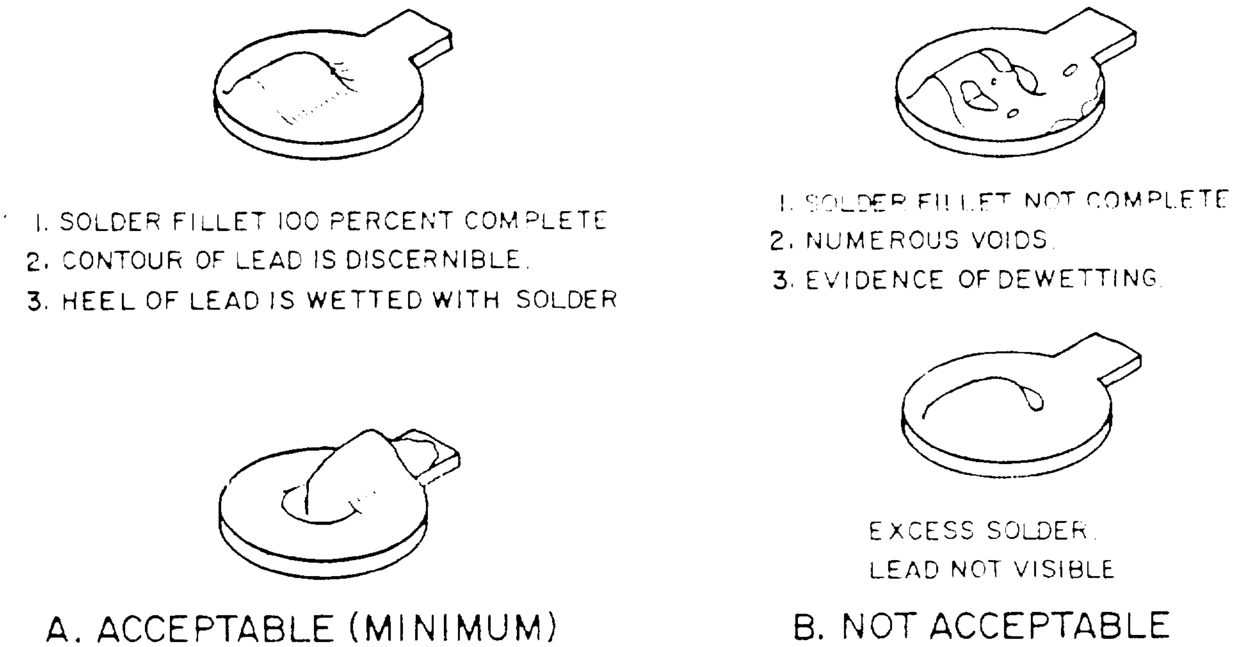


FIGURE 17. Plated-through holes - clinched lead and wires (see 4.19.5.2).

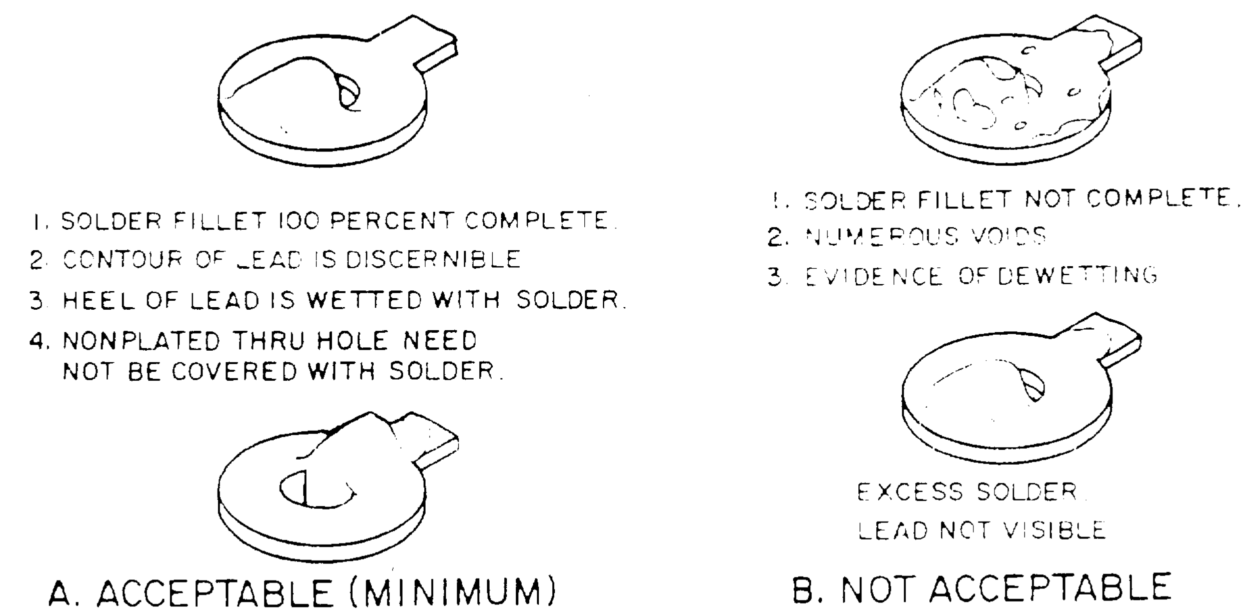


FIGURE 18. Nonplated-through hole - clinched leads and wires (see 4.19.5.2).

4.19.5.3 <u>Planar mounted device round or coined lead solder fillet.</u> Minimum solder fillet height on round or coined leads shall be 25 percent of the original lead diameter. The solder shall extend the length of the lead termination (see figure 19). The solder shall not overhang the land. The outline of the lead must be discernible in the solder (see figure 19).

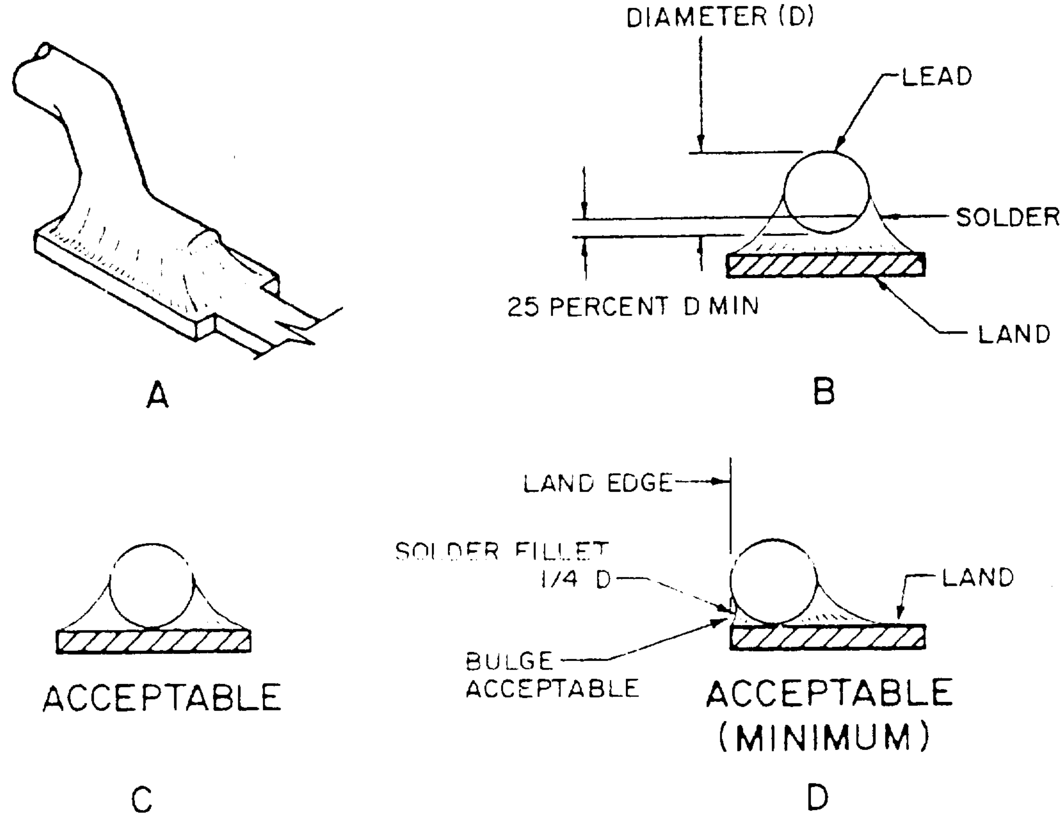


FIGURE 19. <u>Planar mounted device round or coined lead solder fillet (see 4.19.5.3).</u>

4.19.5.4 <u>Planar mounted device flat lead solder fillet.</u> Flat leads shall exhibit a visible fillet rising from the land to the top of the lead whenever the lead is over the land. The solder shall extend the length of the lead termination (see figure 20C). The solder shall not overhang the land. The outline of the lead must be discernible in the solder (see figure 20).

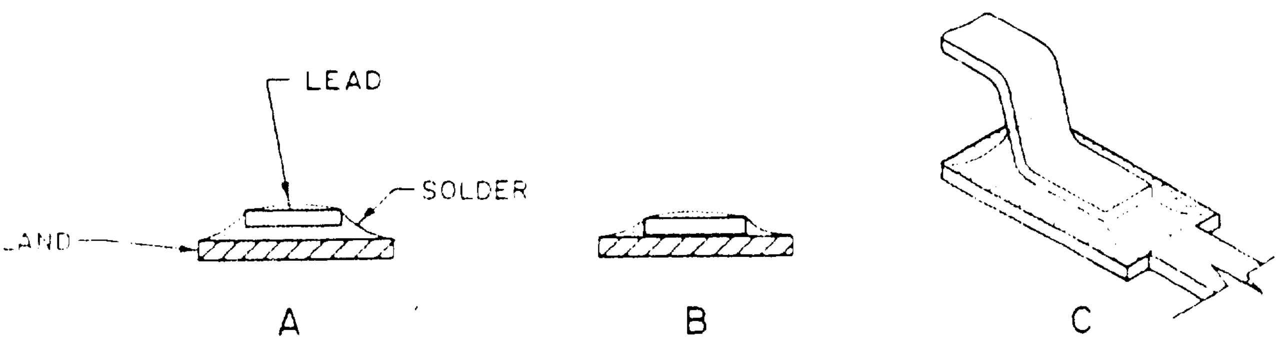


FIGURE 20. <u>Planar mounted device flat lead solder fillet (4.19.5.4).</u>

4.19.5.5 Planar mounted device lead heel fillet. The heel fillet shall be continuous between the heel of the lead and the circuit land. The heel fillet shall extend to the midpoint of the lower bend radius for flat leads. The heel fillet shall extend beyond the full bend radius for round leads. The solder fillet for any lead shall not extend into the start of the upper bend radius (see figure 21). The start of the bend radius between upper and lower bend points for flat and round leads shall be formed in accordance with 4.11.5.

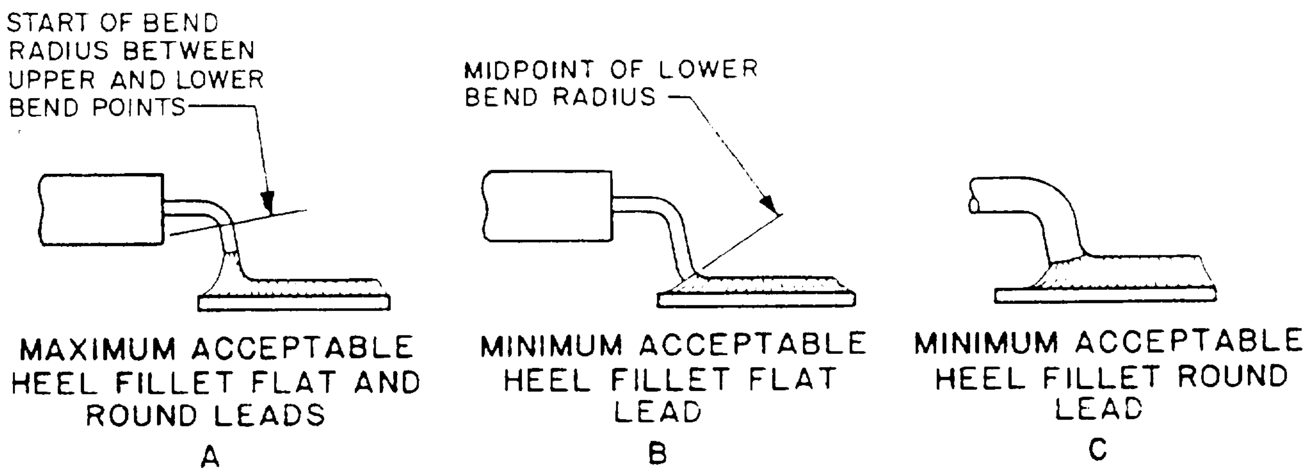


FIGURE 21. Planar mounted device lead heel fillet (see 4.19.5.5).

4.19.5.6 Tool marks on planar mounted device solder fillet. Tool marks resulting from heater bar or lead hold down during soldering operation shall not be cause for rejection (see figure 22).

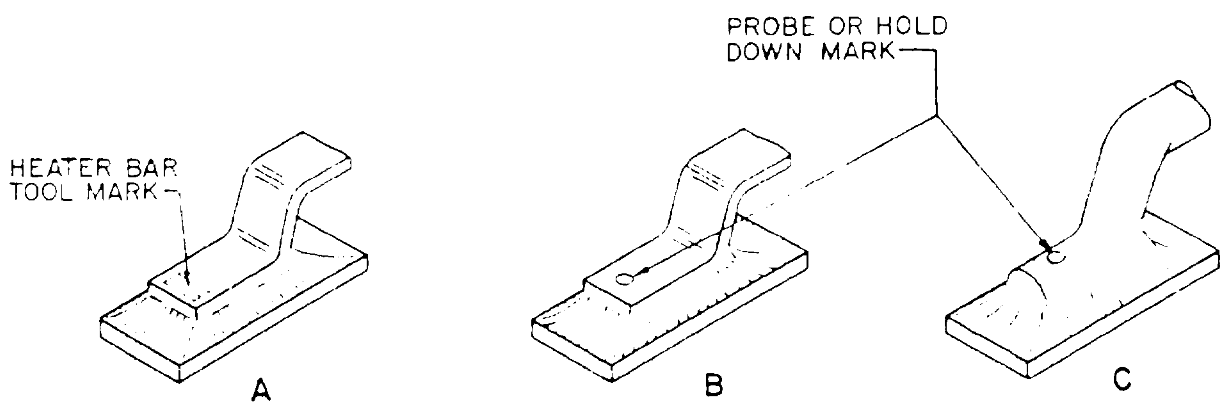


FIGURE 22. Planar mounted device tool marks (see 4.19.5.6).

4.19.5.7 Soldering of wires and leads to turret terminals. Solder shall wet the terminal and wire or lead and form a visible fillet between all areas of contact between the terminal and wire or lead. The solder shall cover the wire or lead over the extent of the wrap but shall not obscure the contour of the wire or lead (see figure 23).

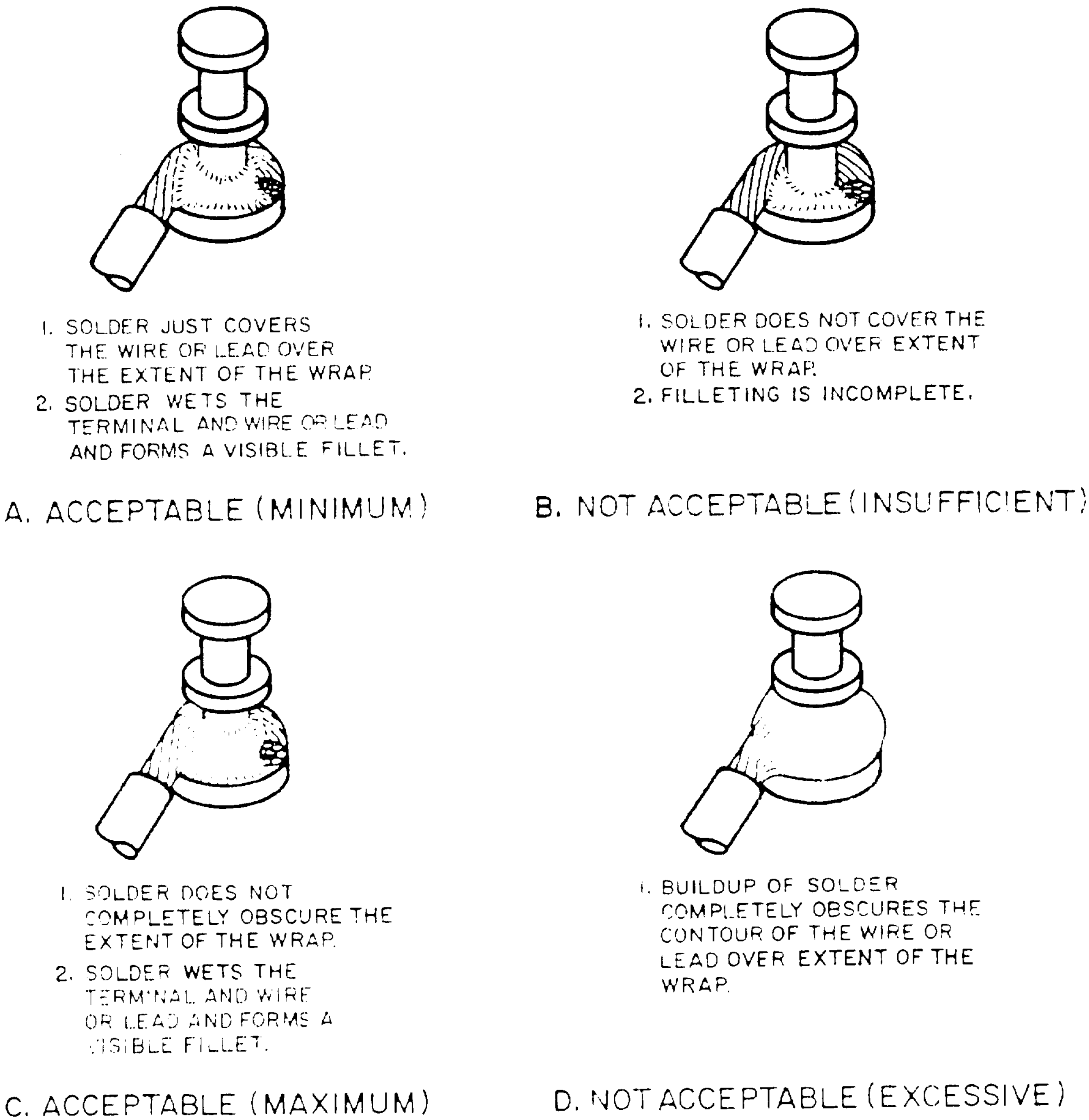
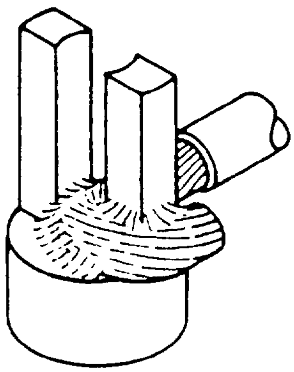


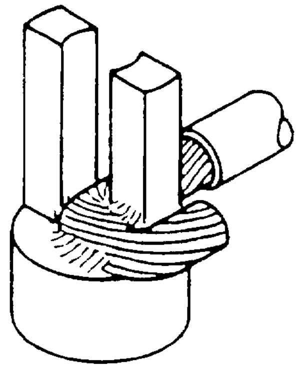
FIGURE 23. Wire and lead soldering to turret terminals (see 4.19.5.7).

4.19.5.8 Soldering of wires and leads to bifurcated terminals. Solder shall cover the wire or lead over the extent of the wrap but shall not obscure the extent of the wrap. The solder shall wet the terminal and wire or lead and form a visible fillet (see figure 24).



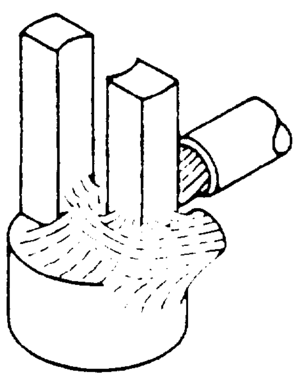
1. SOLDER JUST COVERS THE WIRE OR LEAD OVER THE EXTENT OF THE WRAP
2. SOLDER WETS THE TERMINAL AND WIRE OR LEAD AND FORMS A VISIBLE FILLET.

A. ACCEPTABLE (MINIMUM)



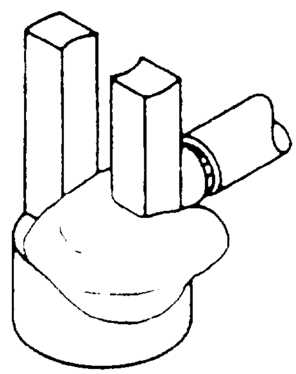
1. SOLDER DOES NOT COVER THE WIRE OR LEAD OVER EXTENT OF THE WRAP.
2. FILLETING IS INCOMPLETE.

B. NOT ACCEPTABLE (INSUFFICIENT)



1. SOLDER DOES NOT COMPLETELY OBSCURE THE EXTENT OF THE WRAP.
2. SOLDER WETS THE TERMINAL AND WIRE OR LEAD

C. ACCEPTABLE (MAXIMUM)

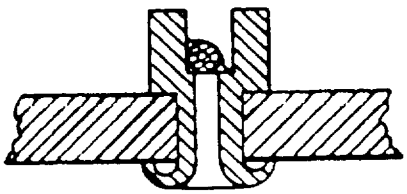


1. A BUILDUP OF SOLDER COMPLETELY OBSCURES THE CONTOUR OF THE WIRE OR LEAD OVER EXTENT OF THE WRAP.

D. NOT ACCEPTABLE (EXCESSIVE)

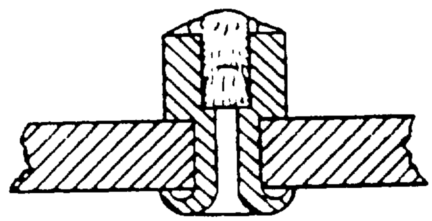
FIGURE 24. Wire and lead soldering to bifurcated terminals (see 4.19.5.8).

4.19.5.9 Soldering of wires and leads to slotted terminals. As a minimum solder shall form a fillet with that portion of the wire or lead that is in contact with the terminal. Solder may completely fill the slot but shall not be built up on top of the terminal. The wire or lead shall be discernible in the terminal (see figure 25).



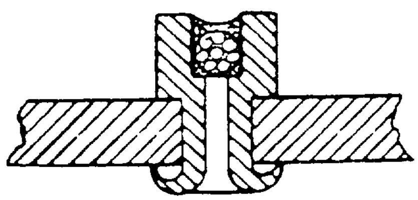
1. MINIMUM AMOUNT OF SOLDER ALONG THE WIRE OR LEAD.
2. WIRE OR LEAD END DISCERNIBLE IN TERMINAL.

A. ACCEPTABLE (MINIMUM)



1. SOLDER BUILDUP ON TOP OF TERMINAL.
2. WIRE OR LEAD NOT DISCERNIBLE THROUGH TERMINAL.

B. NOT ACCEPTABLE



1. MAXIMUM AMOUNT OF SOLDER COMPLETELY FILLS SLOT.
2. WIRE OR LEAD END DISCERNIBLE IN TERMINAL.

C. ACCEPTABLE (MAXIMUM)

FIGURE 25. Wire and lead soldering to small slotted terminal (see 4.19.5.9).

4.19.5.10 <u>Soldering of wires and leads to hook terminals</u>. Solder shall wet the terminal and wire or lead and form a visible fillet between all areas of contact between the terminal and wire or lead. The solder shall cover the wire or lead over the extent of the wrap but shall not obscure the contour of the wire or lead (see figure 26).

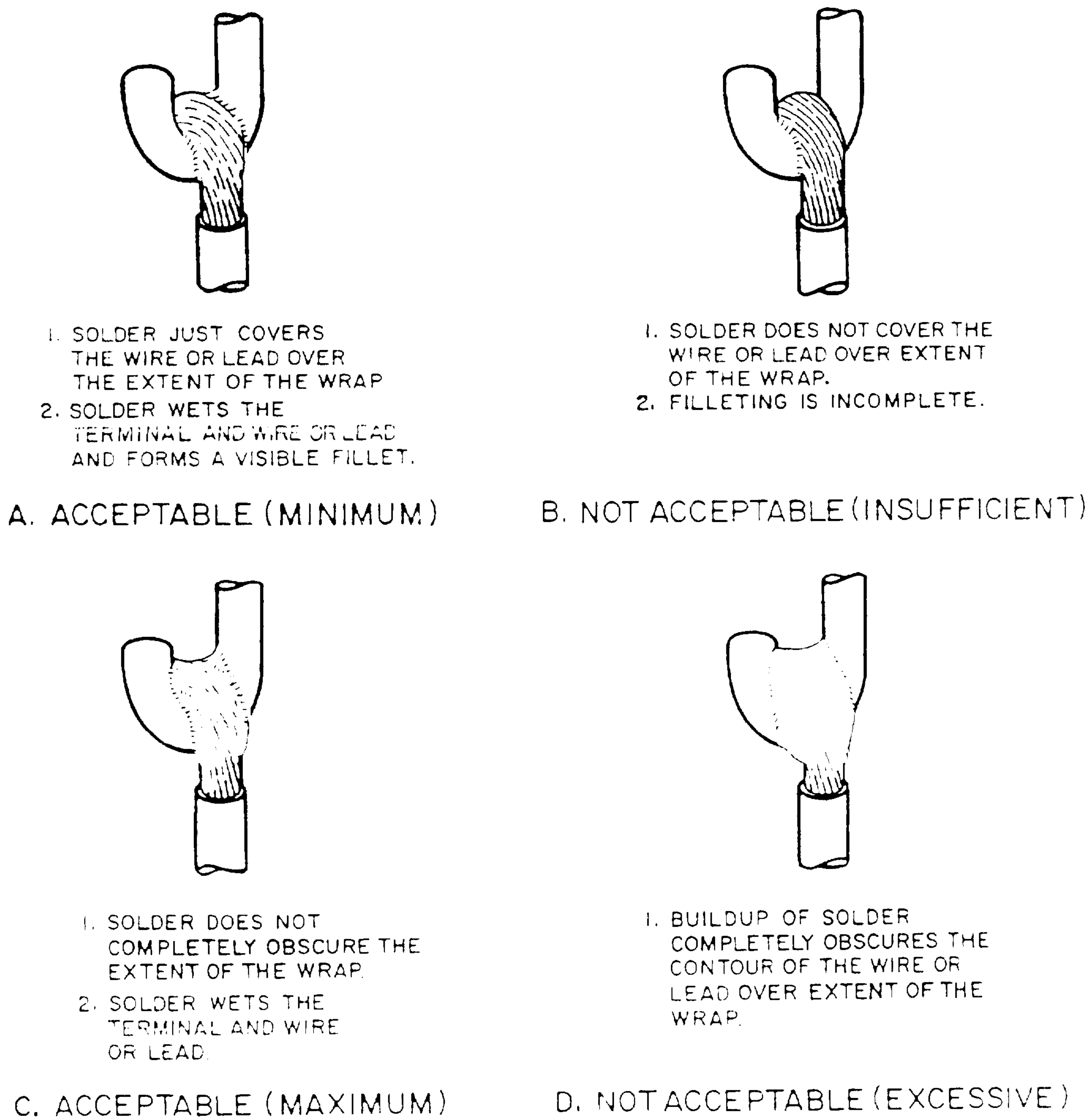
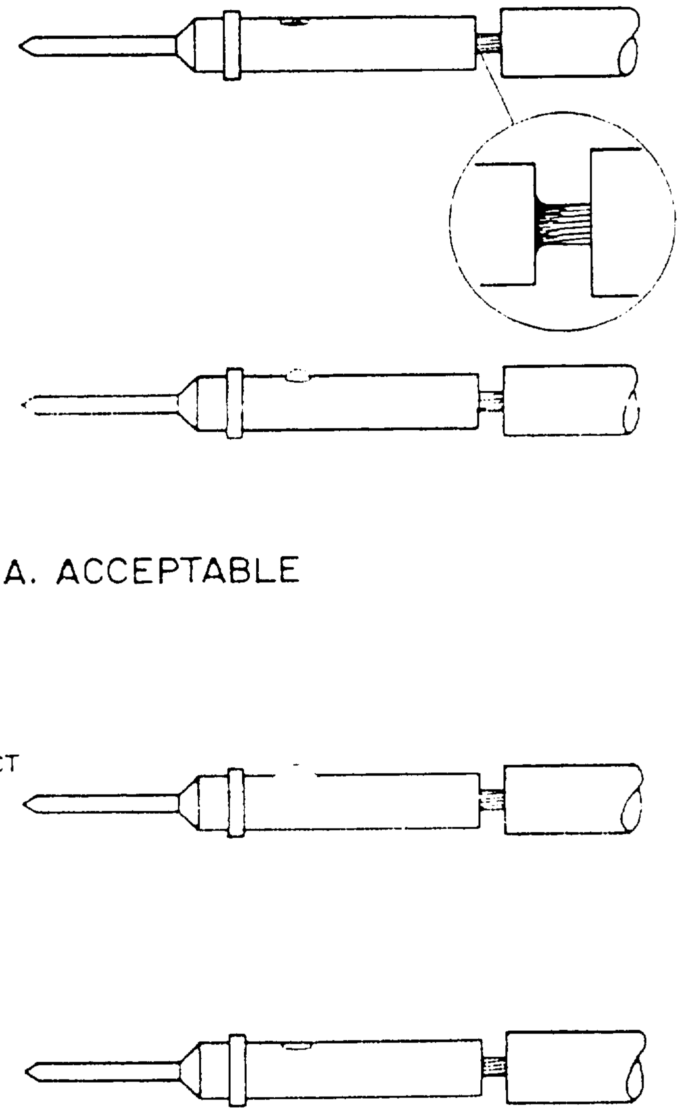


FIGURE 26. <u>Wire and lead soldering to hook terminals (see 4.19.5.10)</u>.

4.19.5.11 Soldering of wires and leads to contacts. Solder shall visibly wet between the cup and wire or lead. Any solder on the outside surface of the solder cup shall be in the form of a thin film only. Solder shall be visible in the inspection hole, may rise slightly above it, but shall not spill onto the side of the contact (see figure 27).



1. SOLDER VISIBLE IN INSPECTION HOLE.
2. SOLDER WETTING BETWEEN WIRE OR LEAD AND CUP IS VISIBLE.
3. ANY SOLDER ON THE OUTSIDE SURFACE OF THE SOLDER CUP IN THE FORM OF A THIN FILM ONLY.

1. SOLDER SLIGHTLY ABOVE INSPECTION HOLE.
2. SOLDER WETTING BETWEEN WIRE OR LEAD AND CUP IS VISIBLE.

A. ACCEPTABLE

1. EXCESSIVE SOLDER AND SPILLAGE ON SIDE OF CONTACT
2. SOLDER WETTING BETWEEN WIRE OR LEAD AND CUP IS NOT VISIBLE.

1. SOLDER NOT VISIBLE IN INSPECTION HOLE.
2. SOLDER WETTING BETWEEN WIRE OR LEAD AND CUP IS NOT VISIBLE

B. NOT ACCEPTABLE

FIGURE 27. Wire and lead soldering to contacts (see 4.19.5.11).

4.19.5.12 Soldering of wires and leads to solder cups. Solder shall wet between the cup and wire or lead. The wire or wires shall be in contact with the back wall of the cup for the full depth of the cup and a fillet shall be formed along the surfaces of contact. Solder shall wet the entire inside of the cup. Solder shall follow the contour of the cup and shall fill the cup at least 75 percent of the mouth of the cup (see figure 28). Solder may overfill the cup but shall not overflow on the sides of the cup. Tinning (thin solder film) of the outside of the cup is permissible (see figure 28).

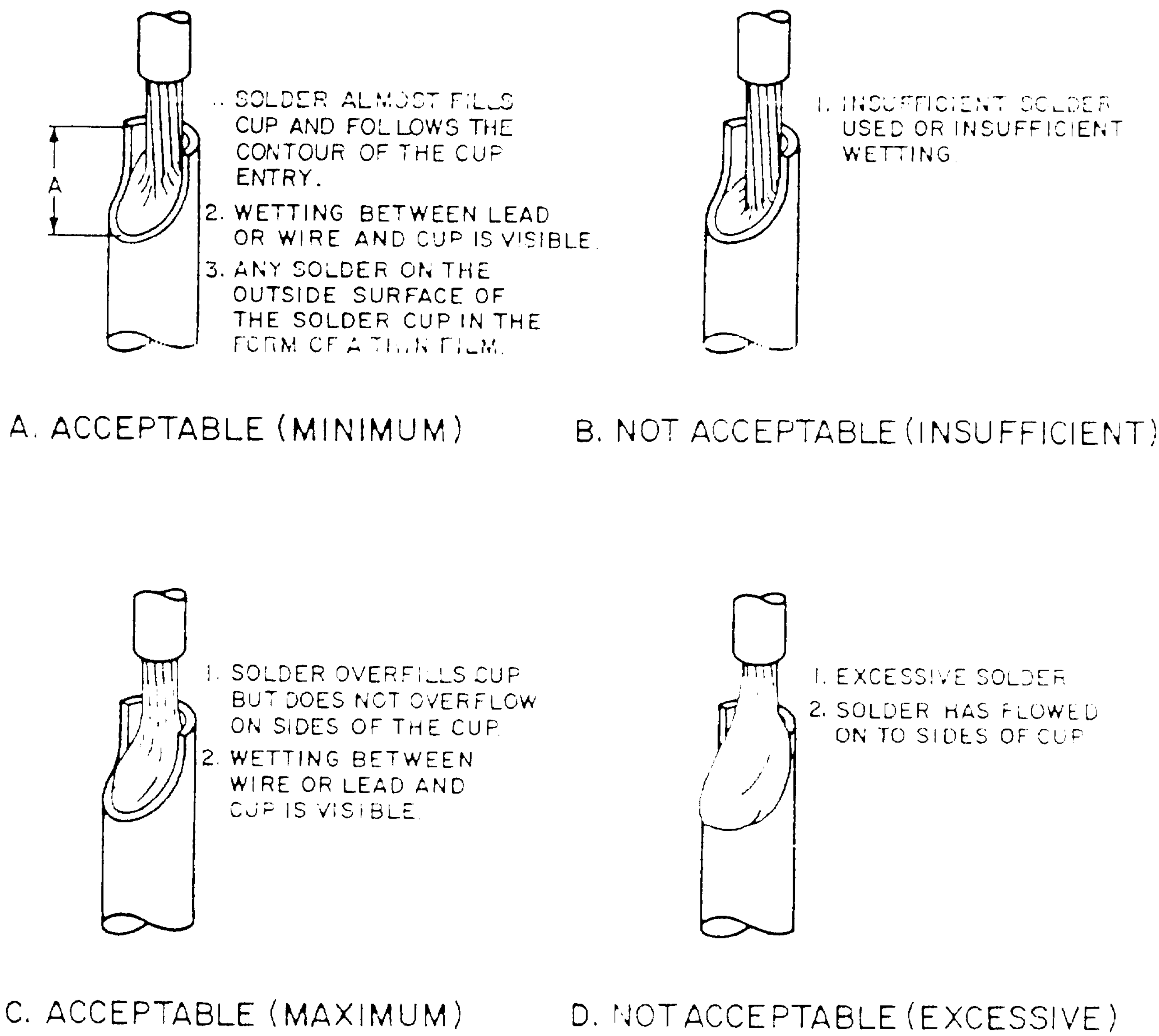


FIGURE 28. Wire and lead soldering to solder cups (see 4.19.5.12).

4.19.6 Voids. A void whose surface is less than 5 percent of the surface area of the solder connection is acceptable provided the inner surface of the void is totally visible when viewed with the magnification specified herein (see figure 29).

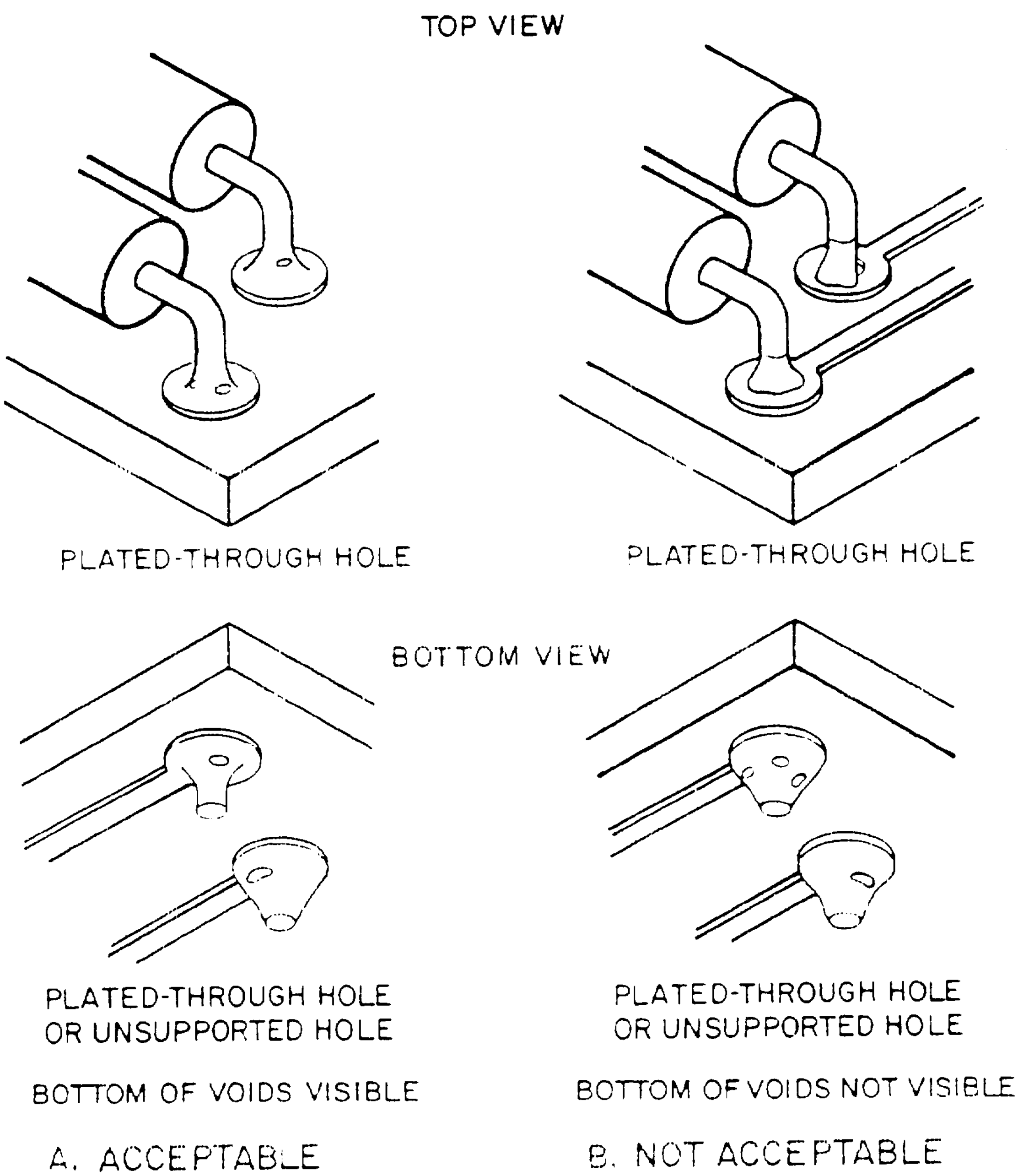


FIGURE 29. Plated-through holes-voids (see 4.19.6).

4.19.7 Connector terminations for heat shrinkable solder devices. The terminal and lead contours shall be visible and shall not be obscured by solder. Solder fillet and connection area shall be clearly discernible along the terminal and lead interface. The solder shall lose all appearance of a ring shape and the contour of the solder preform shall not be visible. With the exception of minor "browning," the wire insulation shall not be damaged outside of the sleeve (see figures 30 and 31).

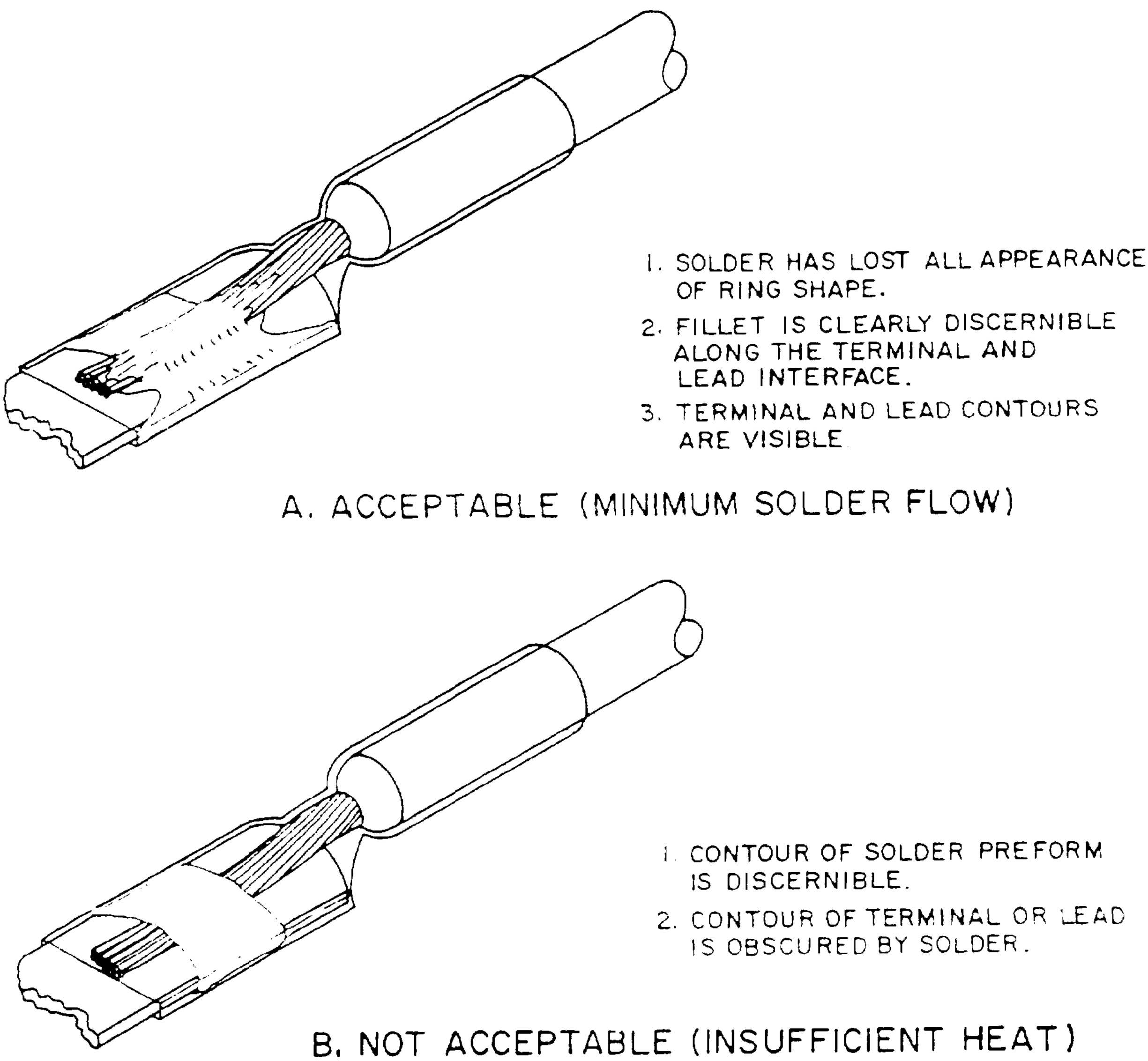
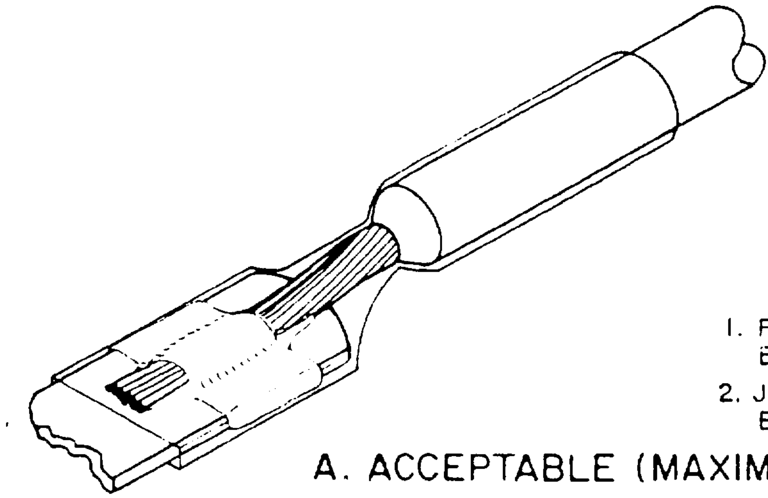
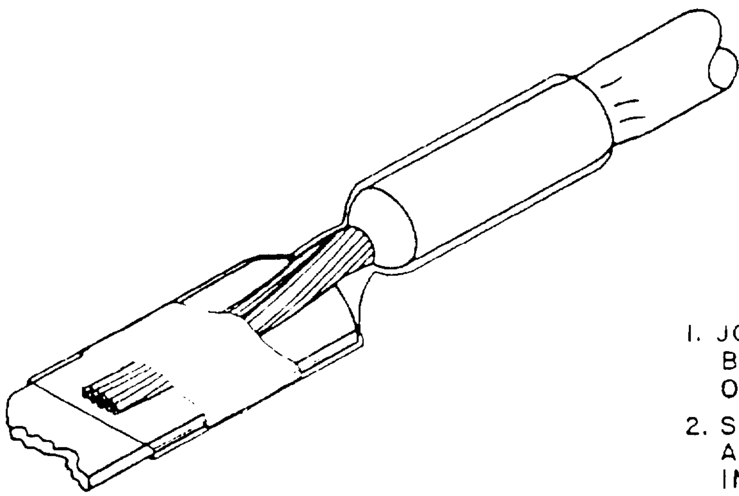


FIGURE 30. Heat shrinkable solder devices-connector terminations (see 4.19.7).



1. FILLET IS CLEARLY DISCERNIBLE BETWEEN TERMINAL AND LEAD.
2. JOINT AREA IS VISIBLE DESPITE BROWNING OF SLEEVE.

A. ACCEPTABLE (MAXIMUM SOLDER FLOW)

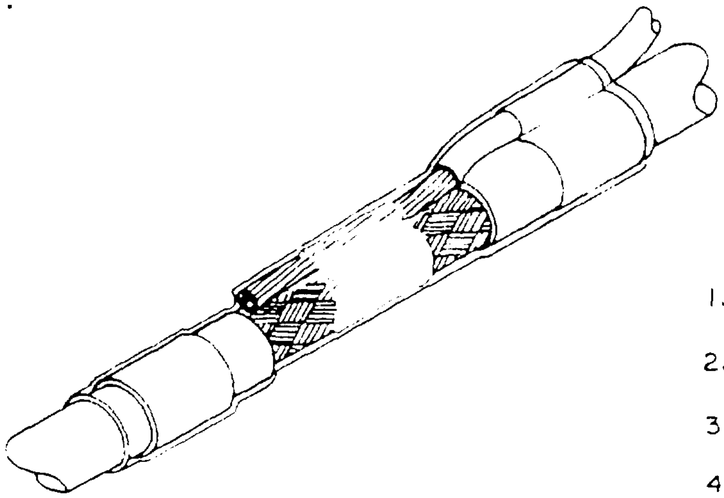


1. JOINT AREA IS NOT VISIBLE BECAUSE OF SEVERE DARKENING OF THE OUTER SLEEVE.
2. SOLDER FILLET IS NOT DISCERNIBLE ALONG TERMINAL AND LEAD INTERFACE.
3. WIRE INSULATION DAMAGED (BROWNING ACCEPTABLE) OUTSIDE OF SLEEVE.

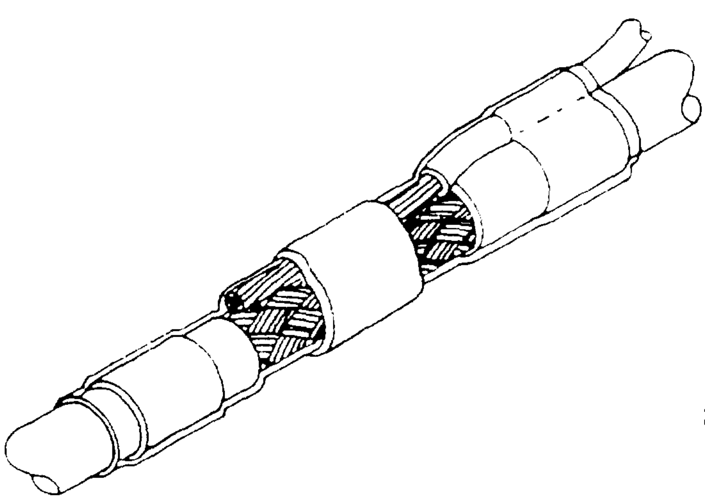
B. NOT ACCEPTABLE (OVERHEATED)

FIGURE 31. Heat shrinkable solder devices-connector terminations (see 4.19.7).

4.19.8 Shield terminations for heat shrinkable solder devices. A fillet shall be clearly discernible along the lead and shield interface. The solder shall lose all appearance of ring shape and the contour of the solder preform shall not be visible. Inserts shall melt and flow along the wires. The shield and lead contours shall be visible and the contour of the braid or lead shall not be obscured by solder. The outer sleeve may be darkened, but the connection area shall be visible. With the exception of minor "browning," the wire insulation shall not be damaged outside of the sleeve (see figures 32 and 33).

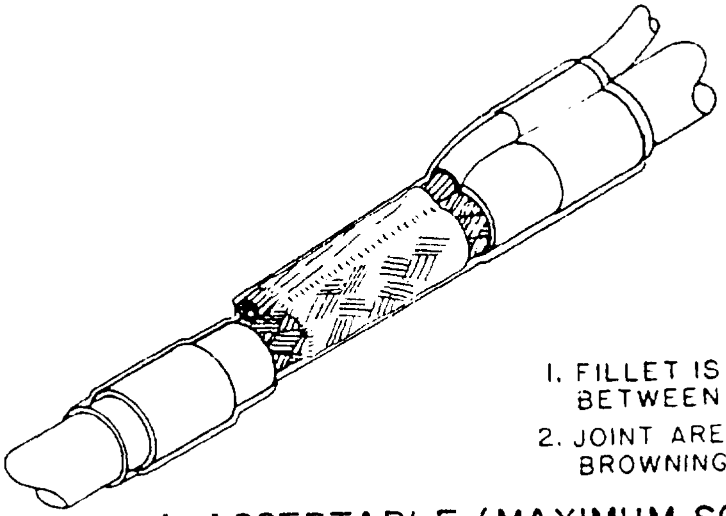


A. ACCEPTABLE (MINIMUM SOLDER FLOW)



B. NOT ACCEPTABLE (INSUFFICIENT HEAT)

FIGURE 32. Heat shrinkable solder devices-shield terminations (see 4.19.8).



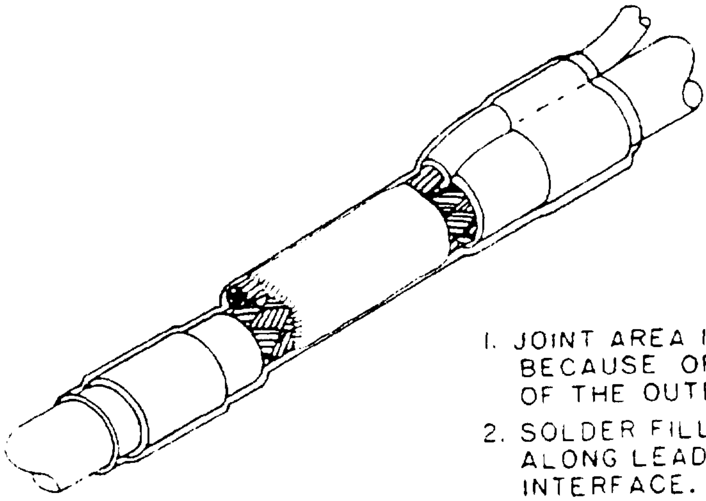


FIGURE 33. Heat shrinkable solder devices-shield terminations (see 4.19.8).

4.19.9 Typical visual characteristics for identifying solder connection and soldered assembly defects. The descriptions provided herein are for information and are not implied requirements. These are only defects within the limits specified elsewhere in this document.

4.19.9.1 Rosin connection (see 4.19.3.1). A rosin connection is a connection with a layer of solidified flux entrapped in or between the connection elements.

4.19.9.2 Cold solder connection (see 4.19.2.2). A cold solder connection is a connection in which the solder has not properly flowed and wetted the surface and the solder does not feather out on the connection elements.

4.19.9.3 Disturbed solder connection (see 4.15 and 4.19.2). A disturbed solder connection is characterized by stress lines and a localized granular zone which may include minute fractures.

4.19.9.4 Insufficient solder connection (see 4.19.4 and 4.19.5). An insufficient connection has characteristics similar to good solder connection, except that the width of the fillet at the narrowest point is less than the diameter of the wire (undercut).

4.19.9.5 Excessive solder connection (see 4.19.4 and 4.19.5). The solder obscures the outline of the wire, the amount of wrapping around the terminal, the outline of the terminal, or the outline of the top or milled portion of a solder cup and generally has a characteristic convex fillet.

4.19.9.6 Ruptured plating or pattern delaminated (see 4.5). A separation of the conductive pattern or ground planes from the laminate base material or the separation of plating from the foil.

4.19.9.7 Dewetting (see 4.19.5). Dewetting is a surface condition wherein no basis metal is exposed, but the solder covering the surface has receded into irregularly shaped mounds surrounded by a thin solder film.

4.19.9.8 Nonwetting (see 4.19.5). Nonwetting is a surface condition wherein basis metal is exposed. The basis metal has been in contact with molten solder, but due to insufficient heat, contaminants, insufficient flux, or oxidation, the solder has failed to form an intermetallic bond (wet) with the base material.

4.19.9.9 Measling (see 4.5). Measling is discrete white spots or crosses at weave sections of the laminated base material wherein the glass fibers have separated from the resin. Measling is typically caused by thermal or mechanical stresses.

4.19.9.10 Lifted pad (see 4.5). A lifted pad is the separation of a terminal area from the laminate base material. It is usually caused by excessive thermal or mechanical stress on the pad.

4.19.9.11 Peripheral split (see 4.19.3.3). A peripheral split is the separation of the barrel of a plated-through hole from the periphery of the associated terminal area or a split along the periphery of a swaged terminal.

4.19.9.12 Pin hole (see 4.19.3). A pin hole is a small hole in the surface of a solder connection penetrating to an indeterminant size void within the connection.

4.19.9.13 Scratched printed circuit pattern (see 4.5). A scratched circuit pattern is distinguishable by a scratch on the surface of a printed wiring pattern which exposes basis metal or damages the board laminate.

4.19.9.14 Voids and blow holes (see 4.19.3). Unacceptable voids and blow holes are those whose inner surface is not completely visible or voids which cover more than 5 percent of the soldered surface.

4.19.9.15 Pit (see 4.19.3). A surface imperfection whose entire inner surface is visible and which covers more than 5 percent of the soldered surface is unacceptable.

4.19.9.16 Contaminated connection (see 4.19). Connections that have inclusions (flux residues, cotton fibers, foreign matter, dirt on or embedded in the solder surface), metal oxides, and other matter in the connection are contaminated. They are characterized by discernible matter on or in the solder or dull, gray, or nonmetallic appearing surfaces.

4.19.9.17 Overheated connection (see 4.19.2.1). The solder has a chalky, dull or crystalline appearance and may show evidence of coarse grain porosity or pitting.

4.19.9.18 Solder not smooth and shiny (see 4.19.2). Solder connections which are not smooth and shiny but have a dull, grainy, and gray appearance.

4.19.9.19 Solder splatter (see 4.19.3). Solder balls clinging to the surface of the laminates or foil are the most common form of solder splatter.

4.19.9.20 Solder slivers, points, peaks, protrusions and icicles (see 4.19.3). Slivers consist of plating overhang or conductive edges partially or completely detached. Solder projections (points, peaks, icicles) consist of protrusions of solder from solidified solder.

4.19.9.21 Excessive wicking. Excessive wicking may be characterized by solder extending to the wire insulation, enlargement of the wire, or a change in wire stiffness beyond the allowed maximum distance from the soldered connection.

NOTE: This applies to soldered connections in finished assemblies. Criteria for pretinned wires are contained in 5.4.17.6 (when applicable, see 1.2.3).

4.19.9.22 Thermal damage. Thermal (heat) damage may be characterized by discoloration, blistering, flowed material and evidence of burned parts or assemblies (charring or scorching). Slight discoloration is not cause for rejection.

4.19.9.23 Bridging (see 4.19.3). Bridging is a conductive path, not part of the design, spanning between conductors which is caused by the presence of materials such as solder, plating, leads, wires, or ionic residue.

5. DETAIL REQUIREMENTS

5.1 Application of requirements. The requirements of this section are intended to provide added degrees of quality assurance through the implementation of process controls. Proper specification of these requirements will improve the quality of the hardware procured while minimizing unnecessary costs associated with improper requirements selection.

5.1.1 Baseline requirements. When a contract, detail specification or drawing requires MIL-STD-2000, the requirements of paragraph 4., General Requirements, and all subparagraphs shall be performed. The requirements of paragraph 5., Detail Requirements, are applicable only when a specific reference is made to the paragraph or one of tasks listed below. When an applicable requirement in 5. specifies a limit which differs from the corresponding limit in 4., the requirement in 5. shall take precedence. Where an applicable requirement in 5. is related to a requirement in 4. but does not specify superseding limits, the distinct but related elements of both requirements shall apply.

5.1.2 Applicability. The requirements of this section (paragraph 5.2 through 5.6) are recommended for use as guidance for all assemblies manufactured for Department of Defense agencies. They shall be considered mandatory requirements only when the tasks identified in 1.2.1 are specified in the contract or the detail specification for the item procured.

5.2 Task A: Certification of contractor personnel.

5.2.1 Certification. Records of certification as to the ability of personnel to meet the Task G requirements of this standard shall be made available to the government. Personnel shall be certified in accordance with the requirements specified herein, prior to performing operations on engineering or experimental models, prototype models, or deliverable articles.

5.2.2 Prime contractor personnel. All prime contractors shall have at least one Category C instructor and examiner.

5.2.3 Visual acuity. All candidates for certification in any category (see 5.5.3) shall, as a minimum, meet the following vision requirements:

a. Far vision: Snellen chart 20/50, or better.

b. Near vision: Jaeger 1 of 0.50 mm letters at 14 inches (35.56 cm) or better.

c. Color perception: Normal as determined by means of standard color plates (i.e., Dvorine pseudo-isochromatic plates, Ishihara plates, or equivalent).

All personnel certified to this standard shall be given an eye test by an accredited eye examiner to determine their ability to meet these vision requirements. Frequency of eye tests shall be annually for persons 35 years of age or older and every two years for persons less than 35 years of age, except frequency for an individual may be increased if so prescribed by a licensed ophthalmologist. Use of prescription lenses to meet the vision requirements is permissible. When such lenses are required, the certification card shall so state and such lenses shall be used whenever soldering or inspection is being performed. When a binocular microscope, with individually adjustable eyepieces, is used for the soldering or inspection operation, prescription lenses are not required. Failure to meet any of these requirements shall disqualify a candidate for training and certification or shall result in revocation of any certification previously granted.

5.2.4 Certificate categories. Certificates shall be issued in the following categories:

C Contractor Instructor and Examiner
D Inspector (Contractor)
E Operator (Contractor)
H Process Examiner
R Restricted Operator or Inspector

Contractor personnel (category C and H) shall be certified by an approved school; contractor personnel (categories D, E, and R) shall be certified by the contractor.

5.2.4.1 Category C Contractor instructor and examiner.

5.2.4.1.1 Category C Contractor personnel. Category C personnel shall be contractor personnel certified after satisfactory completion of an 80 hour soldering course (see 5.2.9.4). Category C personnel shall be recertified every two years.

5.2.4.1.2 Category C Authority. Category C personnel are authorized to train or require recertification of personnel of categories D, E, and R provided that the personnel are in the employ of:

a. The same company, or

b. a division of the same company, or

c. a subcontractor of the same company as that which employs the category C person on a full time basis.

Category C personnel are authorized to monitor soldering processes and workmanship for compliance to this standard, to perform inspections for conformance with this standard, and to determine the operations or procedures that are appropriate for a category R inspector or operator.

5.2.4.2 Category D Inspector.

5.2.4.2.1 Category D Contractor personnel. Category D personnel shall:

a. have completed all requirements for Category E operator as specified in 5.2.4.3, and

b. be certified by the contractor after satisfactory completion of an additional 20 hour minimum inspector course conducted by a certified Category C instructor and examiner.

5.2.4.2.2 Category D Authority. Category D personnel are authorized to perform inspections for conformance with this standard provided that the personnel are in the employ of:

a. The same company, or

b. a division of the same company, or

c. a subcontractor of the same company as that which employs the category C person on a full time basis.

5.2.4.3 Category E Operator.

5.2.4.3.1 Category E Contractor personnel. Category E personnel shall be certified by the contractor after satisfactory completion of a 40-hour soldering course conducted by a certified category C instructor and examiner.

5.2.4.3.2 Category E Authority. Category E personnel are authorized to perform soldering operations in conformance with this standard provided that the personnel are in the employ of:

a. The same company, or

b. a division of the same company, or

c. a subcontractor of the same company as that which employs the category C person on a full time basis.

5.2.4.4 Category H process examiner.

5.2.4.4.1 Category H personnel. Category H personnel shall be certified by the Government after satisfactory completion of an 80-hour soldering course, with primary emphasis on inspection and machine processes. Category H personnel shall be recertified every two years. Contractors are not required to have Category H personnel as all requirements for Category H personnel may be accomplished by Category C personnel.

5.2.4.4.2 Category H Authority. Category H contractor personnel are authorized to recommend recertification of contractor personnel of categories D, E and R, to inspect contractor soldering processes and workmanship for conformance to this standard and to perform quality assurance actions.

5.2.4.5 Category R Restricted operator or inspector.

5.2.4.5.1 Category R Contractor personnel. Category R personnel shall be selected by the contractor for performance of specific operations or procedures. The training program shall, as a minimum, include the operations or procedures for which the category R personnel are to be certified. Functions or operations using a category R operator or inspector at the contractor facility require prior approval of the government. Similar operations conducted by a subcontractor requires approval of the prime contractor and is subject to review by the government.

5.2.5 Achievement of certified status. To be certified in category C or H, personnel shall attend and successfully complete an 80-hour formal training program at a Government approved school (see 5.2.9.4). To be certified in category D, personnel shall attend and successfully complete a 60-hour formal training program conducted by a category C instructor and examiner. To be certified in category E, personnel shall attend and successfully complete a 40-hour formal training program conducted by a category C instructor and examiner.

5.2.6 Training programs.

5.2.6.1 Contractor training program.

5.2.6.1.1 General. The contractor shall establish and maintain an effective written training program to qualify, certify and recertify all personnel performing operations applicable to this standard under the cognizant Government activity contracts and shall include subcontracts, interplant work orders, and purchase orders. The program shall provide for training using the methods, equipment and materials described in this standard. Upon satisfactory demonstration of proficiency, personnel shall be issued a contractor certificate. The contractor shall prepare and maintain records of personnel training and performance. Use of the Standardized Government Industry Soldering Training Plan, TP MIL-STD-2000, is authorized.

5.2.6.1.2 Training records. The contractor's training records shall be maintained as specified in the contract and shall include, for each trainee during the time of his or her certification, the following:

a. The most recent trainee fabricated test specimen depicting satisfactory conformance to the applicable requirements of this standard.

b. Graded copies of written tests.

c. Employer, plant division, and location of employment.

d. Certification category.

e. Date of certification or recertification.

f. Records of latest visual acuity examination.

5.2.6.1.3 Program evaluation. The training program is subject to review by the government to assure that the program is compatible with this standard. The training program may be disapproved any time the requirements of this standard are not being met.

5.2.7 Cross-certification of subcontractors. Subcontractor personnel certified by one prime contractor in accordance with this standard may be considered certified and utilized by a second prime contractor only with the concurrence of the certifying prime contractor.

5.2.7.1 Prime contractor controls. Prime contractors are responsible for the work performed by their subcontractors. Prime contractors shall ensure that certified subcontractor personnel continuously demonstrate adequate knowledge and technique to perform in compliance with the requirements of this standard. A prime contractor may require certified subcontractor personnel to be recertified.

5.2.7.2 Certification records. Prime contractors shall require that records of certified subcontractor personnel be maintained in accordance with paragraph 5.2.6.1.2.

5.2.7.3 Certification limitations. Category R personnel and all other personnel certified under special conditions, shall be ineligible for cross-certification under these provisions. This limitation includes but is not limited to Category D and E personnel who were certified under contracts that included special process allowances. These operators and inspectors shall be recertified to the basic requirements of this standard prior to use by a second prime contractor.

5.2.7.4 Recertification. Personnel certified by a prime contractor shall be recertified by a prime contractor (not necessarily the same prime contractor) in accordance with the requirements of 5.2.4 and 5.2.5.

5.2.8 Maintenance of certified status.

5.2.8.1 General. Based on a quality audit, review of inspection data, or observation of quality of articles fabricated, soldering personnel involved may be required to either demonstrate proficiency or be retrained in the category concerned and be recertified (see 5.2.9).

5.2.8.2 Continuous performance evaluation. Category D, E, and R personnel shall be subjected to a continuous performance evaluation as specified in 5.2.9.

5.2.9 Recertification.

5.2.9.1 Requirements. Recertification shall be required under the following circumstances:

a. Proficiency requirements herein are not met.

b. New techniques have been developed which require new skills.

c. Certificate holder changes employer.

d. There is a reason to question proficiency or workmanship.

e. Work period interruptions exceeding 90 days (categories C, D, E, H and R).

f. Two years after last certification for Category C and H.

g. Twelve months after last certification for Category D, E, and R.

5.2.9.2 Procedures. The recertification procedure shall be as follows:

a. Every two years Category C and H personnel shall attend a minimum 24-hour recertification course conducted by one of the certification centers (see 5.2.11). Personnel passing the recertification course will have their certification extended for a period of two years. Category C and H personnel failing to demonstrate proficiency shall be required to satisfactorily complete a certification course prior to further performance.

b. When 5.2.9 applies, category C and H personnel shall be recertified after attending a recertification course, and demonstrating proficiency.

c. Category D, E and R personnel shall be recertified as required herein. All recertification programs shall include a requirement to score a minimum of 80 percent correct on a written test compatible with that taken in the original certification course.

5.2.10 Revocation of certified status. Certifications issued by the contractor shall be revoked when the:

a. Certificate holder fails to be recertified when required.

b. Contractor training program fails to meet the requirements of this standard.

c. Certificate holder leaves employment of the contractor for which certificate was originally issued.

d. Certificate holder fails to meet visual acuity requirements.

e. Quality of work does not meet the requirements of this standard.

5.2.11 Certification resources. Personnel shall be certified to Category C or H at one of the schools listed below.

a. U.S. Army Communications and Electronics Command (CECOM)
Attn: AMSEL-PT-HRD-QT (Bldg 918)
Ft. Monmouth, NJ 07003
AV 992-5335
(201) 532-5335

b. U. S. Army Munitions and Chemical Command (AMCCOM/ARDEC)
Attn: AMSMC-QAN-T(D) (Bldg 19)
Suresh Patel
Picatinny Arsenal, NJ 07801-5006
AV 880-4466
(201) 724-4466

c. U. S. Army Missile Command (MICOM)
Redstone Arsenal, AL (205) 876-5902

d. Naval Avionics Center (NAC)
Indianapolis, IN (317) 353-3025

e. Naval Weapons Center (NWC)
China Lake, CA (619) 446-5571

5.3 Task B: Design and Component Mounting Requirements.

5.3.1 Design requirements information. The following paragraphs provide design information on the subjects indicated. Where differences exist between this standard and documents referenced herein, the requirements of this standard takes precedence.

5.3.2	Rigid printed wiring boards
5.3.3	Reference to rigid flex printed wiring
5.3.8.1	Obscuring of termination
5.3.8.2	Moisture traps
5.3.8.3	Vibration
5.3.8.4	Insulation of metal case components
5.3.8.5	Perpendicular mounting
5.3.11	Interference spacing
5.3.12	Part clearance spacing
5.3.13	Part piggybacking
5.3.15	Jumper wires
5.3.16	Eyelets
5.3.17	Resins and other adhesives
5.3.19	Part mounting
5.3.19.1	Hole obstruction
5.3.19.2	Lead to hole diameter relationship
5.3.19.4	Use of unsupported holes
5.3.19.4.1	Leads in plated-through holes
5.3.19.4.2	Clinched lead terminations
5.3.19.5	Wiring to board
5.3.19.6	Lead straightness
5.3.19.7.2	Heat dissipation
5.3.19.7.3	Cross conductor mounting
5.3.19.7.5	Maximum combined lead lengths
5.3.19.7.6	Stress relief provisions
5.3.19.8	Chip device mounting
5.3.19.9	Nonaxial-leaded components
5.3.19.9.1.1	Mounting requirements of nonaxial leaded components

5.3.19.9.1.2	Mounting requirements of standard components
5.3.19.9.2	Dual lead components
5.3.19.9.3	Metal power packages
5.3.19.9.5	Potentiometers
5.3.19.9.6	Tall profile components
5.3.19.10.5.3	DIPs in sockets
5.3.19.10.5.4	DIPs mounted to heat sinks
5.3.19.10.5.5	DIP material
5.3.19.11.2.1	Planar mounting
5.3.19.12.5	Washers under rolled flanges
5.3.19.12.6	Foil pad as seating for rolled flanges
5.3.19.13.7	Terminals and plated-through holes
5.3.19.13.8	Terminals and plated-through holes with rolled flange

5.3.2 Rigid printed wiring boards. Rigid printed wiring boards (PWB) shall be designed to MIL-STD-275 and fabricated to MIL-P-55110 except as modified herein. When used, blind and buried vias shall be incorporated in the test coupon. Minimum spacing between conductive patterns of printed wiring boards shall be in accordance with conductor spacing requirements of tables VIII and IX if the printed wiring board is not to be conformally coated or encapsulated. The use of uncoated printed wiring boards shall be documented on the government approved assembly drawing.

TABLE VIII. Conductor spacing (uncoated printed wiring boards (sea level to 10,000 feet).

Voltage between conductors DC or AC peak (volts)	Minimum spacing
0-150	0.025 inch (0.64 mm)
151-300	0.050 inch (1.3 mm)
301-500	0.100 inch (2.54 mm)
Greater than 500	0.0002 inch (0.0051 mm) per volt

TABLE IX. Conductor spacing (uncoated printed wiring boards (over 10,000 feet).

Voltage between conductors DC or AC peak (volts)	Minimum spacing
0-50	0.025 inch (0.64 mm)
51-100	0.060 inch (1.5 mm)
101-170	0.125 inch (3.2 mm)
171-250	0.250 inch (6.4 mm)
251-500	0.500 inch (12.7 mm)
Greater than 500	0.001 inch (0.03 mm) per volt

5.3.3 Flexible and rigid flex printed wiring. Flexible and rigid-flex printed wiring shall be in accordance with MIL-P-50884 and MIL-STD-2118 (see 4.5). Part mounting for flexible and rigid flex printed wiring assemblies shall be in accordance with MIL-STD-2118 and detailed supplementary requirements specified herein. When used, blind and buried vias shall be incorporated in the test coupon.

5.3.4 Tubing. Polytetrafluoroethylene tubing shall conform to ASTM-D-3295.

5.3.5 Heat shrinkable tubing. Heat shrinkable tubing shall conform to MIL-I-23053 except that use of polyvinylchloride tubing is prohibited.

5.3.6 Extruded vinyl plastic tubing. Extruded vinyl plastic tubing shall conform to MIL-I-7444, type I, or MIL-I-22076.

5.3.7 Interfacial and interlayer connections. Interfacial connections of circuitry on double sided printed wiring boards or assemblies shall be of the plated-through hole configuration of paragraph 5.3.7.1 or the clinched wire configuration of paragraph 5.3.7.2. Interfacial and interlayer connections of circuitry of multilayer printed wiring boards or assemblies shall be of the plated-through hole configuration. Standoff terminals, eyelets, rivets, snug fit pins, or braided sleeves shall not be used to provide interfacial or innerlayer connection nor shall terminals, eyelets, rivets, or snug fit pins be installed in any plated-through hole utilized for interfacial or innerlayer connection. Electrically non-functional holes shall be specified as electrically non-functional holes on the engineering assembly drawing and do not need to meet the electrical connection requirements.

5.3.7.1 Plated-through holes used as via holes.

5.3.7.1.1 Hand soldered assemblies. Holes shall be left unsoldered.

5.3.7.1.2 Machine soldered assemblies. Holes may be either left unsoldered or contain a solder plug. Permanent solder mask shall not tent empty plated-through holes. Partially filled holes are not acceptable.

5.3.7.2 Clinched wire interfacial connections. The wire connecting circuitry on opposite sides of the board or assembly which are not completed via a plated-through hole shall be uninsulated, solid, tinned, copper wire and shall be dressed through the unsupported (unplated) hole, clinched, and soldered to the terminal area on each side of the board or assembly. The clinched wire shall contact the terminal area on at least one side of the printed wiring board and shall approximate contact on the other side (normal springback to one half the wire diameter is acceptable). The clinched portions of the wire shall meet the requirements for clinched component leads of 5.3.19.4. Unless both clinched portions are soldered and cooled simultaneously, the two connections shall be step-soldered. (see figure 34)

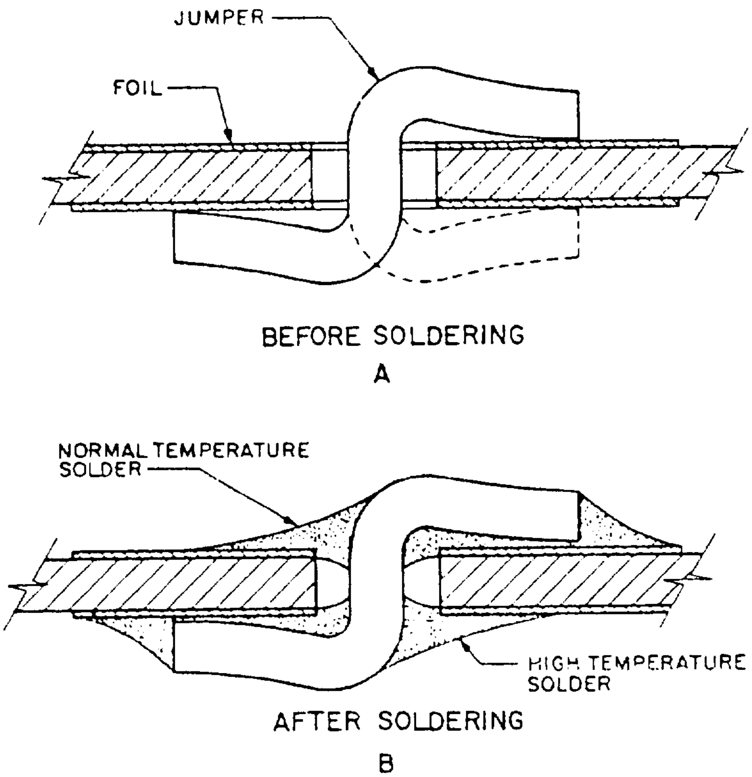


FIGURE 34. Clinched wire interfacial connections (see 5.3.7.2).

5.3.8 Component positioning. Parts and components shall be positioned in compliance with the individual drawings and mounted in accordance with the requirements specified herein.

5.3.8.1 Components shall be mounted so that terminations of other components are not obscured.

5.3.8.2 Parts and components shall be mounted such that the formation of moisture traps is precluded.

5.3.8.3 Components shall be mounted in such a manner so as to withstand all vibration and mechanical shock requirements specified for the end product.

5.3.8.4 Metal cased components which are not otherwise insulated but are mounted over printed conductor wiring shall be insulated from adjacent wiring circuitry and conductor elements. If the addition of insulation is required for conformance with this requirement, an engineering change notice or request for deviation shall be initiated. Insulation material shall be compatible with the circuit and printed wiring board material.

5.3.8.5 Axial-leaded components shall be mounted parallel to the board surface. Perpendicular mounting shall be used only as an existing design documented on a government approved assembly drawing. Under no circumstance shall planar mounting for perpendicular axial leaded components be used.

5.3.9 Visibility of markings. Components shall be mounted insofar as practicable in such a manner that markings pertaining to value, part type, etc., are visible. For parts marked in such a way that some of the marking will be hidden regardless of the orientation of the part, the following shall be the order of precedence for which markings shall be visible.

a. Polarity.

b. Part value.

c. Part type (manufacturer's or DOD part number as applicable for that type part).

d. Traceability code (if applicable).

5.3.10 Part markings and reference designations. Part markings and reference designations shall be legible with letters and numerals unbroken, clearly defined and unsmeared.

5.3.11 Interference spacing. Parts and components shall be mounted such that they do not overhang the edge of a printed wiring board, terminal panel, or chassis member. The minimum spacing for conductive items (components, uninsulated leadwires, metal-cased components, terminals, standoffs, lock-washers and other like items) shall be 0.060 inch (1.58 mm) from the edge of the printed wiring board, the terminal panel, or the chassis member.

5.3.12 Part clearance spacing. Any portion of a bare lead, metallic component body, terminal, or like item shall be spaced at least 0.060 inch (1.58 mm) from one to another except as permitted by MIL-STD-275, MIL-STD-2118, or otherwise specified herein.

5.3.13 Piggybacking. There shall be no piggybacking of parts or components.

5.3.14 Lead forming.

5.3.14.1 Lead malforming limits. Whether formed manually or by machine or die, part and component leads shall not be mounted if the part or component lead evidence nicks or deformation exceeding 10% of the diameter of the lead. Basis metal shall not be exposed.

5.3.14.2 Tempered leads. Tempered leads (sometimes referred to as pins) and untempered leads 0.050 inch (1.3 mm) or greater in diameter or thickness shall not be bent nor formed for mounting purposes inasmuch as body seals and connections internal to the component may be damaged. Neither shall tempered leads be cut with diagonal cutters or other tools which impart ck to connections internal to the component. Untempered leads that are smaller than 0.050 inch (1.3 mm) in diameter shall be clinched when installed in unsupported holes.

5.3.15 Jumper wires. Jumper wires included as a part of the initial design shall conform to the mounting requirements for axial-leaded components.

5.3.16 Eyelets. Eyelets are unacceptable for electrical connections.

5.3.17 Resins and other adhesives. When resins and other adhesives are used, they shall be compatible with the printed wiring board, components, processes and process solvents, solutions and materials.

5.3.18 Solder masks and localized maskants. When used, polymer solder mask coatings shall conform to IPC-SM-840, Class 3 and shall be applied only to surfaces which are not coated with solder or other material which will become semi or totally liquid during subsequent assembly operations. Dry film polymer mask shall be applied by a vacuum laminant process. Polymer solder mask coatings and temporary maskants shall also be of a material that:

a. Does not degrade the substrate material or printed wiring;

b. Precludes solder flow to the masked area;

c. Is compatible, if left in place, with printed wiring board basis material, solder, printed wiring, and subsequently applied conformal coatings; and

d. If temporary, can be readily removed without post-removal residual contamination harmful to board integrity.

5.3.19 Parts and components mounted to printed wiring boards. Axial and nonaxial-leaded components shall be mounted on only one side of a printed wiring assembly if the leads are dressed through holes. Planar mounted components may be mounted on either or both sides of a printed wiring assembly. Components to be mounted shall be designed for and capable of withstanding soldering temperatures incident to the particular process to be used for fabrication of the assembly. When design restrictions mandate mounting components incapable of withstanding soldering temperatures incident to the particular process, such components shall be mounted and hand-soldered to the assembly as a separate operation or shall be processed using a localized reflow technology which is documented and subject to review and disapproval.

5.3.19.1 Hole obstruction. Parts and components shall be mounted such that they do not obstruct solder flow onto the topside termination areas of interfacial, quasi-interfacial, or interlayer plated-through holes (see figure 35).

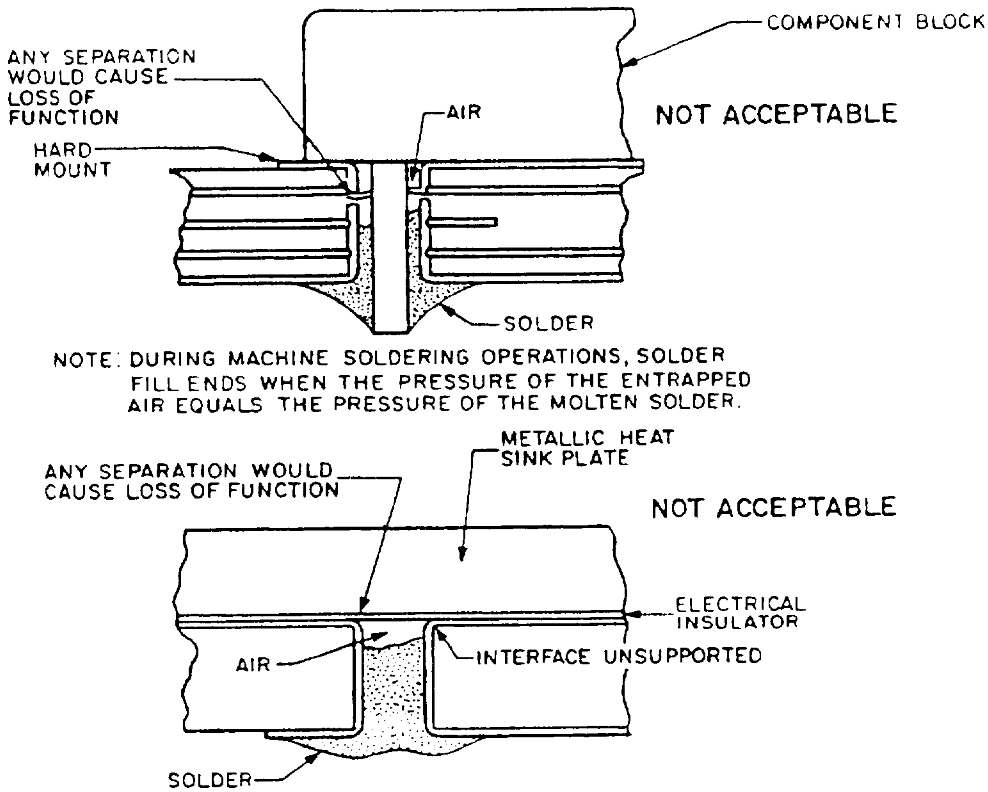


FIGURE 35. Blocked plated-through holes (see 5.3.19.1).

5.3.19.2 Lead-to-hole relationship. No more than one item, whether wire or component lead, shall be inserted in any one hole. Lead-to-hole clearance shall be in accordance with the "Plated-Through Holes" requirement of MIL-STD-275.

5.3.19.3 Lead preforming. Part and component leads shall be preformed to the final configuration excluding the final clinch or retention bend before assembly or installation.

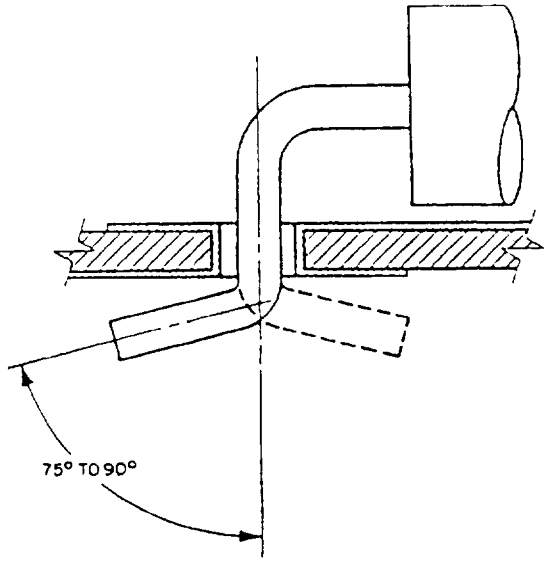
5.3.19.4 Part and component lead terminations. Part and component leads shall be of the clinched, partial clinch or straight-through configuration and shall be terminated in accordance with 5.3.19.4.1. Except for terminal mounting (see 5.3.19.12 and 5.3.19.13), holes that are not plated-through and connection configurations that incorporate offset lands utilized in conjunction with holes that are not plated-through shall be used for part and component lead termination only when documented on a government approved assembly drawing. If unsupported holes are authorized, part and component leads shall be of the full clinched configuration and shall be terminated in accordance with 5.3.19.4.2 including 5.3.19.4.2.1.

5.3.19.4.1 Lead terminations in printed wiring board plated-through holes shall be one of the following configurations: full clinch (Type I, see figure 36), partially clinched (Type II, see figure 36), or the straight through lead termination (Type III, see figure 36). Any angle of clinch or method which provides the necessary restraint during the soldering process is acceptable. Type I is not applicable for leads of dual-in-line packages (DIPS) or pins of other type modules. Types I and II are not applicable for tempered pins or for leads over 0.050 inch (1.3 mm) in diameter.

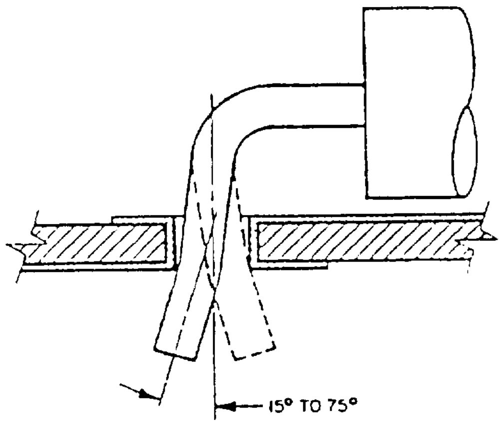
5.3.19.4.2 Clinched lead terminations. The length of the clinched portion of wires and component leads shall be no less than one-half the largest dimension (usually the diameter) of the terminal area or 1/32 inch (0.79 mm), whichever is greater, and no more than the diameter (or length) of the termination area (see figure 37A). The lead length shall be determined prior to soldering (actual measurement is not required except for referee purposes). Lead overhang no greater than 0.032 inch (0.81 mm) is permissible provided that clearance to adjacent conductive elements is no less than 0.015 inch (0.38 mm). When manually clinched, the clinched portion of the wire of lead should be directed along a conductor trace connected to the termination area. When automatically clinched, the orientation of the clinch relative to any trace is optional. The leads on opposite ends or sides of a component shall be directed in opposite directions (see figure 37B). Manually formed clinches for nonaxial leaded components shall be directed radially from the center of the component when the termination area array on the printed wiring board is patterned for such radial orientation.

5.3.19.4.2.1 Fully clinched leads (Type I). Fully clinched leads (Type I) are defined as leads bent between 75 and 90 degrees from a vertical line perpendicular to the board (see figure 36A).

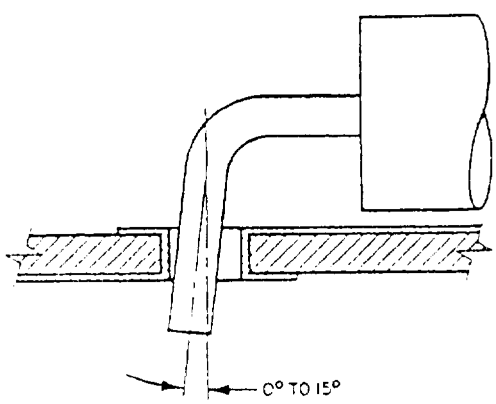
5.3.19.4.2.2 Partially clinched leads (Type II). Partially clinched leads (Type II) shall be bent sufficiently to provide the necessary mechanical restraint during the soldering process. The lead protrusion shall be a minimum of 0.020 inch (0.5 mm) and a maximum of 0.060 inch (1.5 mm) as measured from the conductor surface for the plated-thru-hole (see figure 38). Type II lead terminations shall not be used for manually inserted components except on diagonally opposite corner pins of Dual-in-Line packages (DIPs). The lead length shall be determined prior to soldering (actual measurement is not required except for referee purposes).



A. TYPE I CLINCH CONFIGURATION
(CLINCH FORMED IN EITHER DIRECTION)



B. TYPE II PARTIAL CLINCH
(CLINCH FORMED IN EITHER DIRECTION)



C. TYPE III STRAIGHT-THROUGH CONFIGURATION

FIGURE 36. Plated-through hole lead termination (see 5.3.19.4.1).

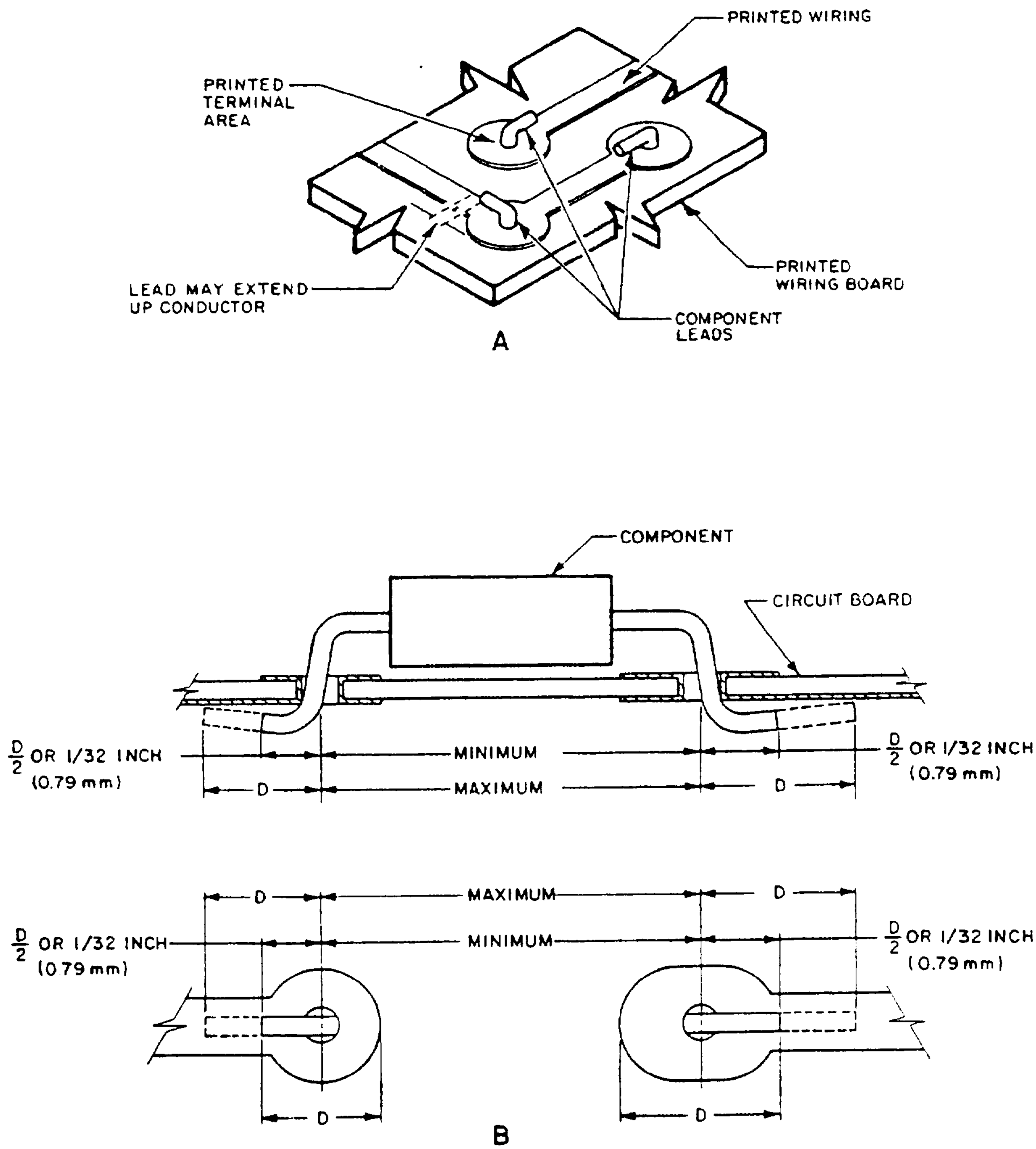


FIGURE 37. Lead termination (clinched leads) (see 5.3.19.4.2).

5.3.19.4.3 Straight-through lead terminations (Type III). Component leads terminated straight through shall extend a minimum of 0.020 inch (0.5 mm) and a maximum of 0.060 inch (1.5 mm) (see figure 38, dimension E). Printed wiring assembly designs which necessitate different lead extensions are considered unique mounting requirements and shall be noted on the government approved assembly drawing. Dimension E of Figure 38 is the distance from the conductor surface to the end of the projected lead. The minimum lead length shall be determined prior to soldering (actual measurement is not required except for referee purposes) (see figure 38).

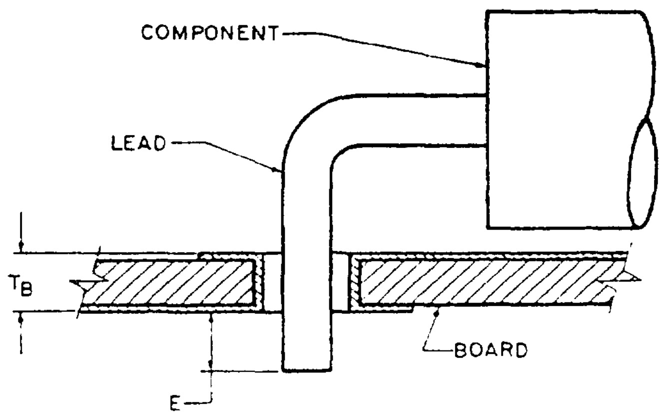


FIGURE 38. Straight-through lead extension (see 5.3.19.4.3).

5.3.19.5 Wiring to printed wiring boards. Interconnect wiring connected directly (not via connectors) to printed boards or printed board assemblies shall be installed in plated-through holes or on turret terminals. Bare tinned wire with added insulating sleeving shall not be used. Wires shall be installed on turret terminals if the wires are subject to removal for normal maintenance action. Insulated solid or stranded wire shall be installed in accordance with 4.11.4.4 as applicable to plated-through holes and to terminals in accordance with 5.3.21 thru 5.3.21.8. Insulated solid or stranded wire installed in plated-through holes in printed boards with base material thickness of 0.020 inch (0.5 mm) or less shall be clinched to the solder side. Mounting of solid conductors of flat ribbon cable or flexible printed wiring in plated-through holes constitutes a unique mounting design. Routing and cabling requirements shall be specified on the assembly drawing.

5.3.19.6 Lead straightness. Leads shall not be bent at the body of the component or between the body of a component and any lead weld and shall extend straight from the body seal and lead weld for at least twice the lead diameter or thickness. For lead diameters of 0.015 inch (0.38 mm) or less, the straight extension shall be 0.030 inch (0.76 mm) (see figure 39).

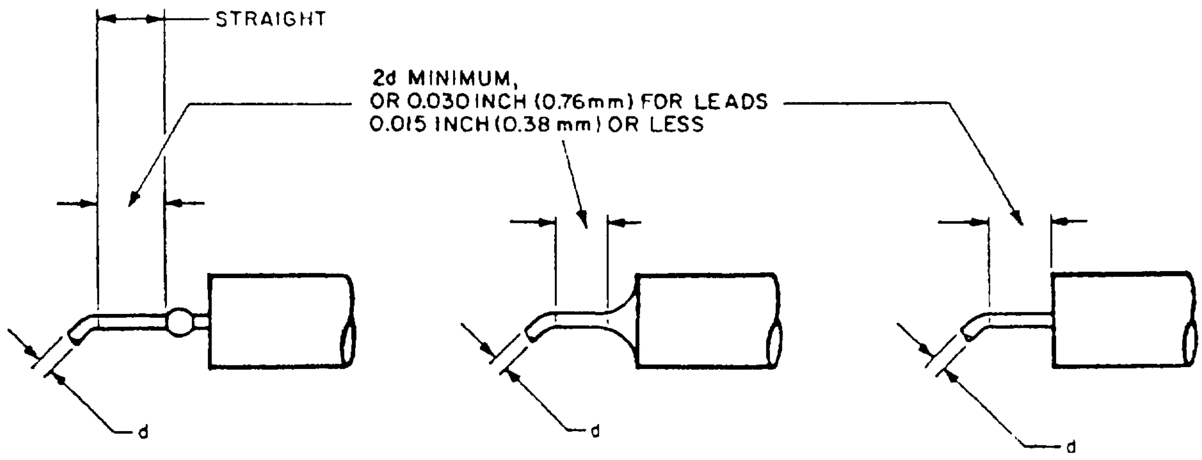


FIGURE 39. Lead straightness (see 5.3.19.6).

5.3.19.7 Axial-leaded components. Axial-leaded components shall be mounted approximately parallel to the board surface (see 5.3.8.5) within the requirements of 5.3.19.7.1.1.

5.3.19.7.1 Physical support. Dependent upon weight and heat generation characteristics, components shall be mounted for support as follows:

5.3.19.7.1.1 Except for planar and authorized perpendicular mounted components (see 5.3.8.5), components weighing less than 1/4 ounce (7.08g) per lead, which dissipate less than 1 watt and are not clamped or otherwise supported, shall be mounted approximately parallel to the board surface and mounted within 0.015 inch (0.04 mm) of the board surface.

5.3.19.7.1.2 All components weighing 1/4 ounce (7.08g) per lead or more shall be supported in a clamp or other device (including embedment) such that the soldered connections are not solely relied upon for mechanical strength (see figure 42).

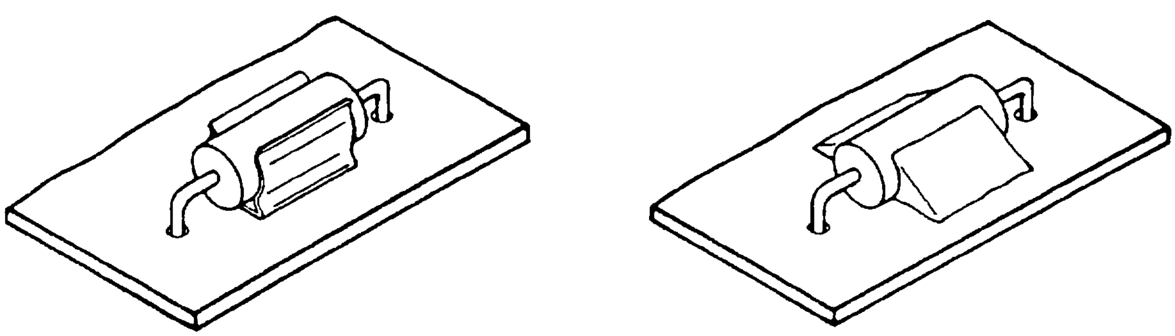


FIGURE 40. Supporting clamp and embedment (see 5.3.19.7.1.2).

5.3.19.7.2 Heat dissipation. Components that dissipate one watt or more during operation shall be mounted in accordance with the engineering assembly drawing. Where conductive materials or devices are used to transfer heat from the parts, the materials or devices shall be compatible with the assembly and cleaning processes.

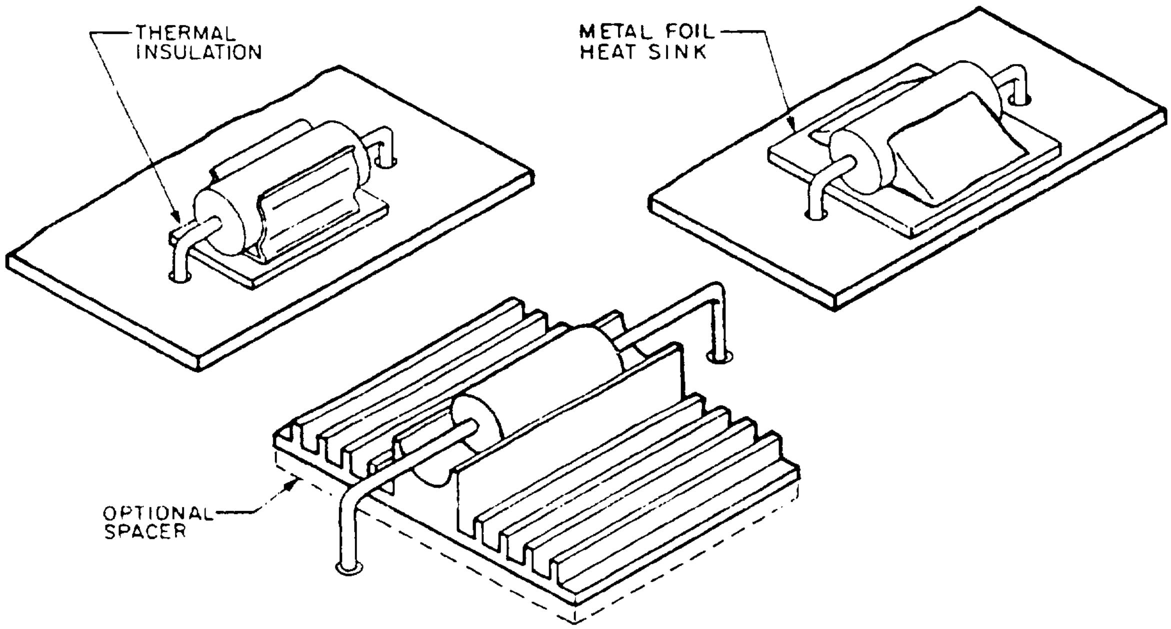


FIGURE 41. Typical heat sinked axial-leaded components (see 5.3.19.7.2).

5.3.19.7.3 Cross conductor mounting. Cross conductor mounting shall be in accordance with the "Electrical part mounting over conductive areas" requirements of MIL-STD-275.

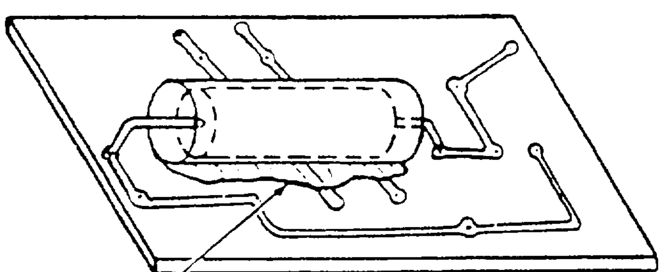


FIGURE 42. Cross conductor mounting (see 5.3.19.7.3).

5.3.19.7.4 Body centering. Except as otherwise specified herein, the bodies (including end seals and welds) of horizontally mounted, axial leaded components should be approximately centered in the span between mounting holes, as shown in figure 43.

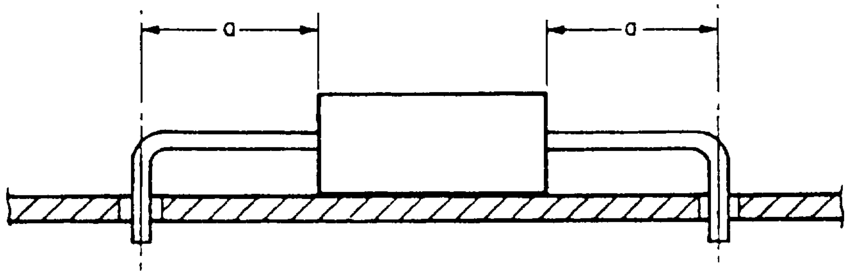


FIGURE 43. Body centering (see 5.3.19.7.4).

5.3.19.7.5 Maximum combined lead length. Unless exception is specified on the the government approved assembly drawings, the combined length of the straight lead extension from the part body (labeled x or y in figure 44) of components mounted horizontally shall not exceed one inch (2.54 cm).

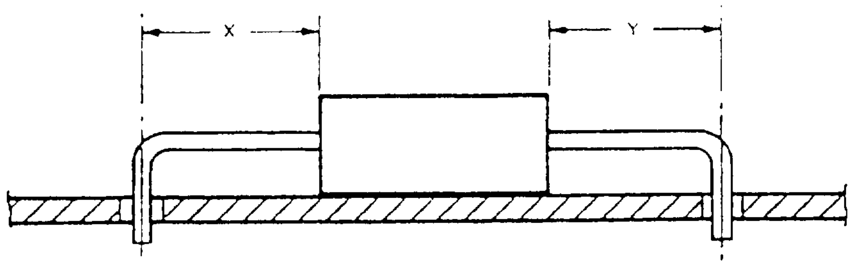


FIGURE 44. Maximum combined length of leads (see 5.3.19.7.5).

5.3.19.7.6 Stress relief provisions. The leads of components mounted horizontally with bodies in direct contact with the printed wiring board or printed wiring thereon shall be mounted with the radius of each relief bend at least 0.030 inch (0.76 mm) but not less than the diameter of the lead. Components shall be mounted in any one or combination of the following configurations:

a. In a conventional manner utilizing 90 degree (nominal) lead bends directly to the mounting hole (see figure 45A).

b. With camel hump bends (see figures 45B and 45C). Configurations incorporating a single camel hump (figure 45B) may have the body positioned off-center.

c. With spacer material attached to the printed wiring board under the component body and using conventional 90 degree (nominal) lead bends (see figure 45D and 45F).

d. With a nylon clip fabricated from MS 21266 plastic edging under the component body and leads formed with conventional 90 degree (nominal) lead bends (see figure 45E).

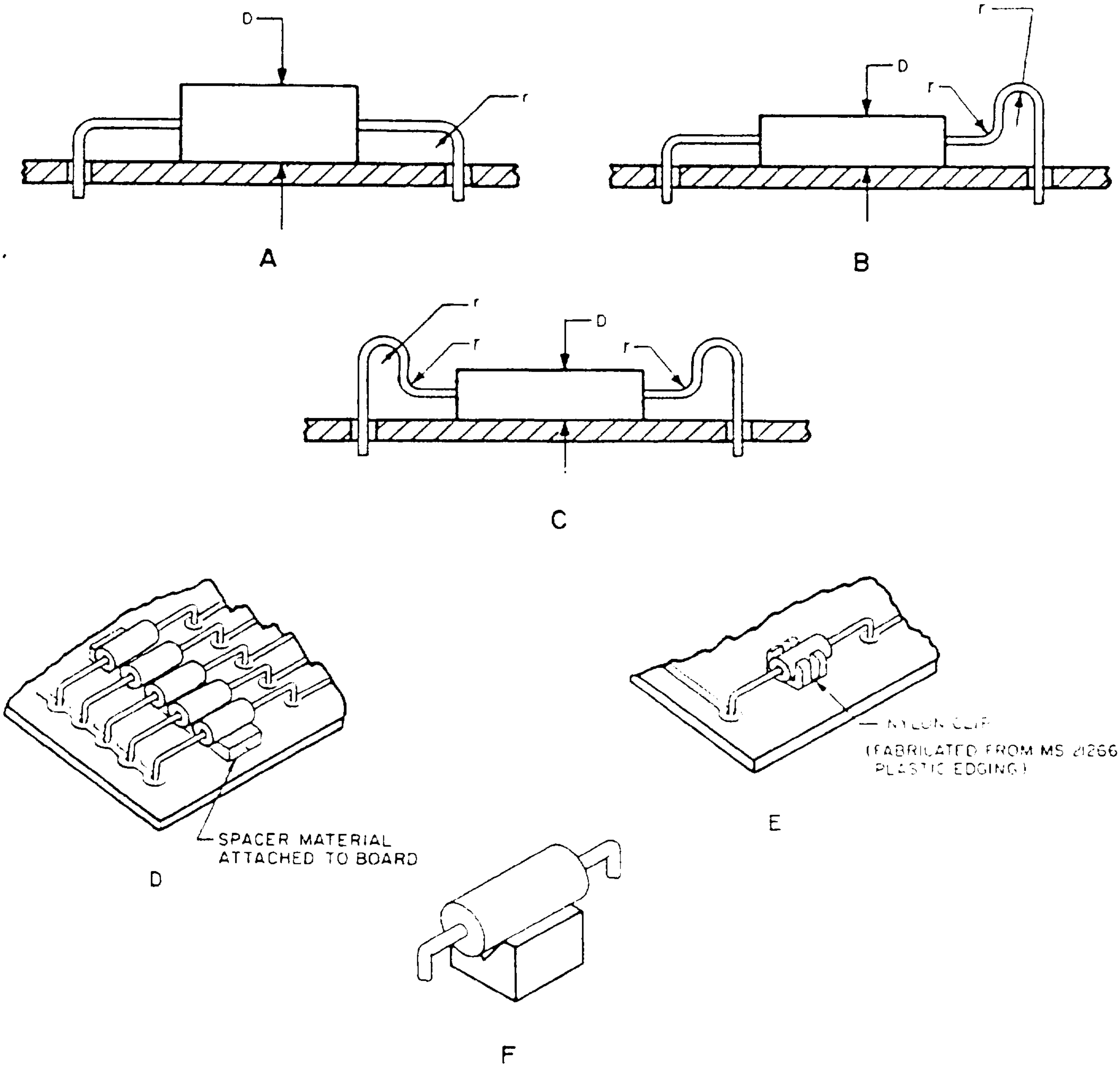


FIGURE 45. Stress relief provisions (see 5.3.19.7.6).

5.3.19.8 Leadless components. End capped chip resistors of the MIL-R-55342 configuration, end capped chip capacitors of the MIL-C-55365/4 configuration, and similar leadless end capped discrete components utilized in miniature and standard assemblies shall be mounted in accordance with 5.3.19.8.1 thru 5.3.19.8.6.

5.3.19.8.1 Chip devices shall be mounted only to printed wiring or printed circuitry; the devices shall not be stacked nor shall they bridge spacing between other parts or components such as terminals or other properly mounted chip devices (see figure 46).

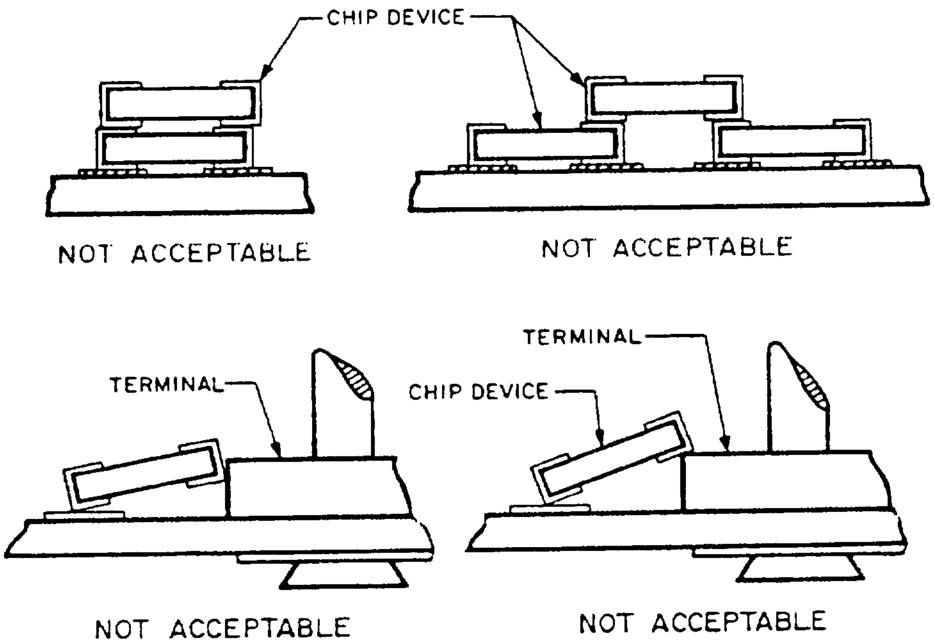


FIGURE 46. Improper mounting of chip devices (see 5.3.19.8.1).

5.3.19.8.2 The device shall be positioned such that the device shall not overhang the terminal area more than 10 percent of the device width (W) (see figure 47). It is preferred that the device be positioned with no overhang. The minimum conductor spacing shall be maintained.

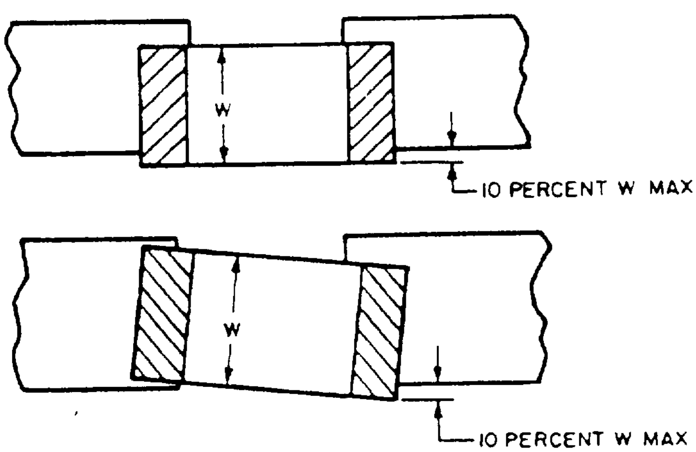


FIGURE 47. Acceptable chip overhang (see 5.3.19.8.2).

5.3.19.8.3 The end cap of the chip device shall extend onto the terminal area a minimum of 0.005 inch (0.13 mm) (see figure 48).

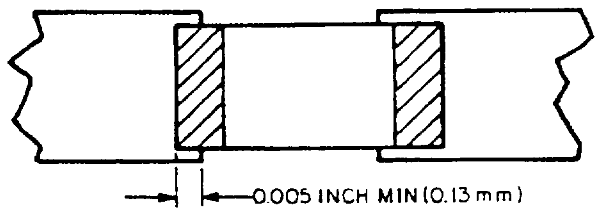


FIGURE 48. Minimum lap of chip on terminal area (see 5.3.19.8.3).

5.3.19.8.4 Mispositioning of chip devices shall not reduce the specified minimum spacing to adjacent printed wiring (see tables I and II) or other metallized elements.

5.3.19.8.5 The device shall be mounted flat and parallel with the surface of the printed board wiring within 10 degrees (see figure 49).

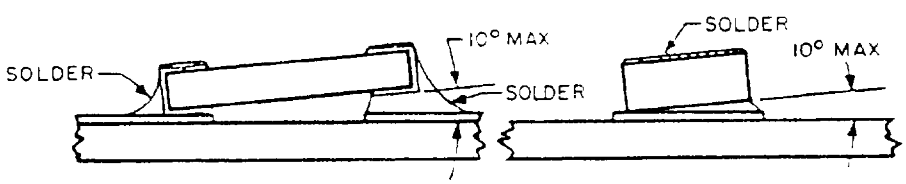


FIGURE 49. Maximum chip canting (see 5.3.19.8.5).

5.3.19.8.6 The space between the body of the soldered-in-place chip device and the terminal areas shall not exceed 0.015 inch (0.38 mm) (see figure 50).

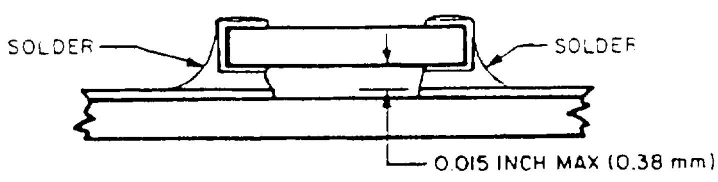


FIGURE 50. Maximum chip elevation (see 5.3.19.8.6).

NOTE: If the vertical (V) dimension of reflow configuration chips is greater than the thickness (T) dimension (see figure 51B), the reflow configuration chips should not be used in assemblies subject to high vibration or shock loads, especially in airborne or missile systems.

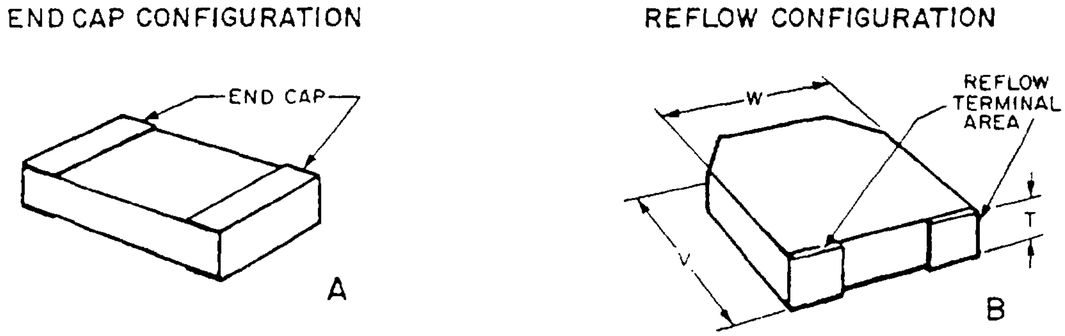


FIGURE 51. Leadless chip components (see Note above).

5.3.19.8.7 If the chip component is secured to the printed wiring board utilizing an adhesive bonding resin, the area of resin coverage shall not flow on to or obscure any of the reflow terminal areas. Part attachment process shall control the quantity and type of bonding material such that the parts are removable without damage to the assembly.

5.3.19.8.8 Components with electrical elements deposited on an external surface (such as chip resistors) shall be mounted with that surface facing away from the printed wiring board or substrates (see figure 52).

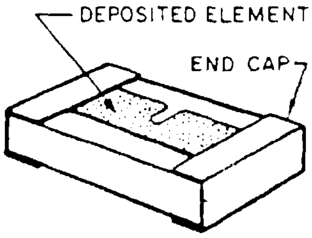


FIGURE 52. Chip resistor (see 5.3.19.8.8).

5.3.19.9 Nonaxial-lead components with leads extending from a single surface. Nonaxial-leaded components shall be:

a. Mounted with the surface from which the leads egress (hereinafter referred to as the BASE SURFACE or BASE) parallel to the surface of the printed board within the spacing tolerances specified herein.

b. Side mounted.

c. Leads shall extend straight from the base a minimum of twice the lead diameter but not less than .030 inch (0.76 mm) except where the leads have been formed during component manufacture.

5.3.19.9.1 Standard components. Mounting of standard components shall be in accordance with 5.3.19.9.1.1 thru 5.3.19.9.1.6 except as specified in 5.3.19.9.2 thru 5.3.19.9.6.

5.3.19.9.1.1 Components shall be mounted freestanding (i.e., with the base surface separated from the surface of the board with no support other than the component leads) only if the weight of the component is 1/8 ounce (3.5 grams) per lead or less. When components are mounted freestanding, the spacing between the surface of the component and the surface of the board shall be a minimum of 0.030 inch (0.75 mm) and a maximum of 0.125 inch (3.175 mm) unless otherwise specified on the assembly drawing (see figure 53). In no instance shall nonparallelism result in nonconformance within the minimum or maximum spacing limits. Specific design limitations (i.e., cross talk in RF applications) shall be noted on the engineering assembly drawing.

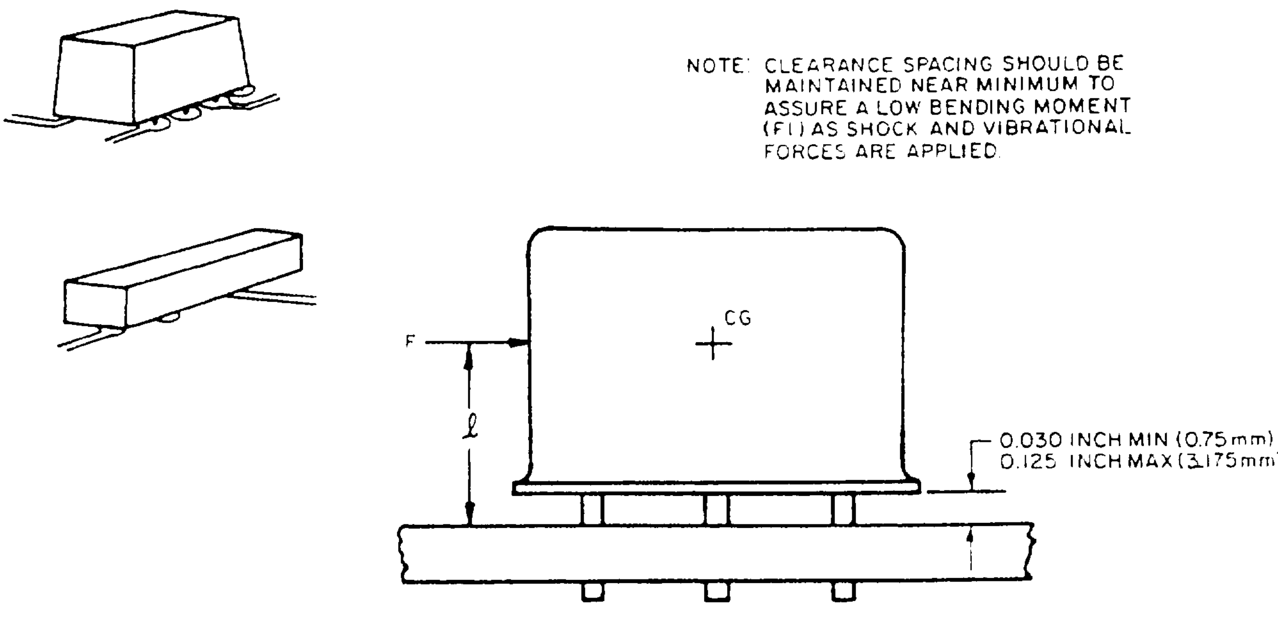


FIGURE 53. Mounting of freestanding nonaxial-leaded components (see 5.3.19.9.1.1).

5.3.19.9.1.2 Components weighing more than 1/8 ounce (3.5g) per lead shall be supported when mounted to a printed wiring board. The component shall be supported on:

a. Resilient feet or standoffs integral to the component body (see Figure 54A and 54B) and the component shall be mounted in contact with the board, or

b. A separate resilient footed or nonfooted standoff (see figure 54C), or a specially configured nonresilient footed standoff (see figure 54D) and shall be mounted in contact with the standoff and the standoff in contact with the board (see figure 55 and 5.3.19.1).

Footed standoffs shall have a minimum foot height of 0.010 inch (0.25 mm). No standoff shall be inverted.

5.3.19.9.1.3 When a specially configured non-resilient footed standoff is utilized, that portion of the lead in the lead bend cavity (see figure 56) shall conform to coincide with an angular line extending from the lead insertion hole in the standoff device to the lead attachment hole in the printed wiring board and seated in accordance with 5.3.19.9.1.2.b.

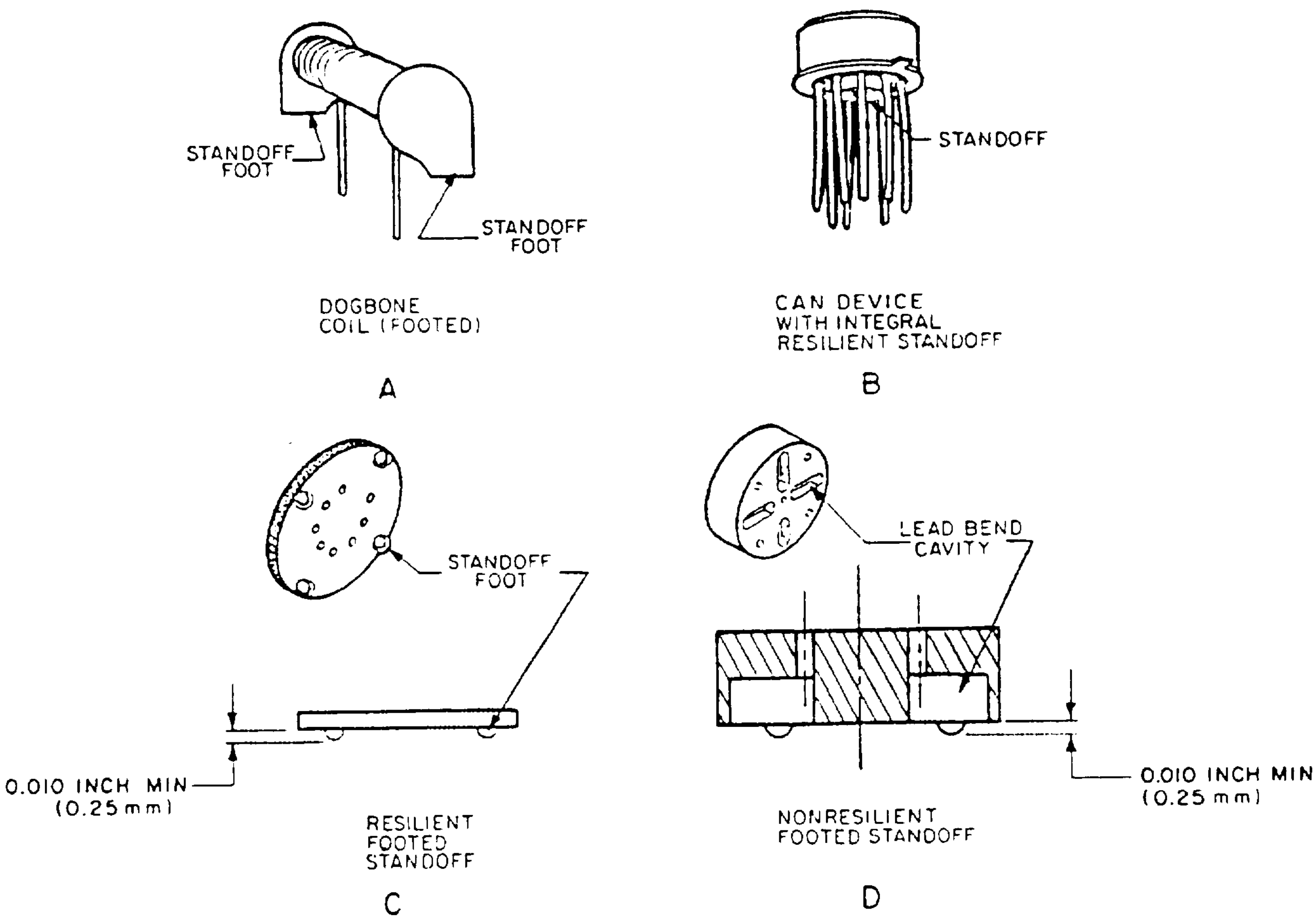
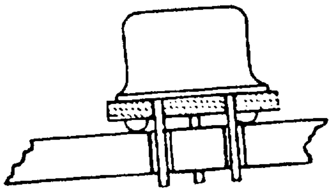


FIGURE 54. Typical standoff devices (see 5.3.19.9.1.2).

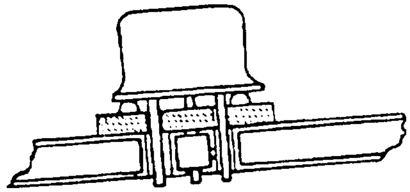


ACCEPTABLE

COMPONENT SEATED FLAT TO STANDOFF.

FEET IN CONTACT WITH BOARD.

A

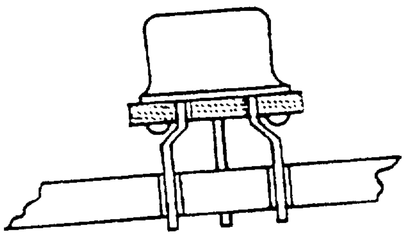


NOT ACCEPTABLE

STANDOFF INVERTED.

STANDOFF BLOCKS PLATED-THROUGH HOLE.

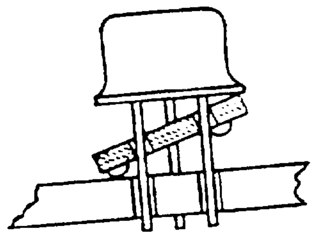
B



NOT ACCEPTABLE

STANDOFF NOT IN CONTACT WITH BOARD.

C



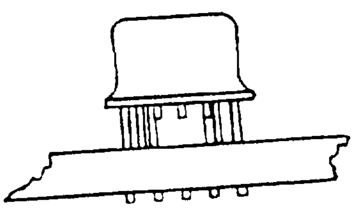
NOT ACCEPTABLE

STANDOFF TILTED.

COMPONENT NOT SEATED FLAT TO STANDOFF.

FEET DO NOT CONTACT BOARD.

D

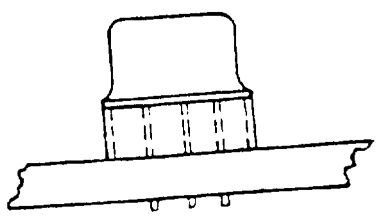


ACCEPTABLE

COMPONENT SEATED FLAT TO STANDOFF OF RESILIENT MATERIAL.

BASE OF STANDOFF FLAT ON BOARD.

E

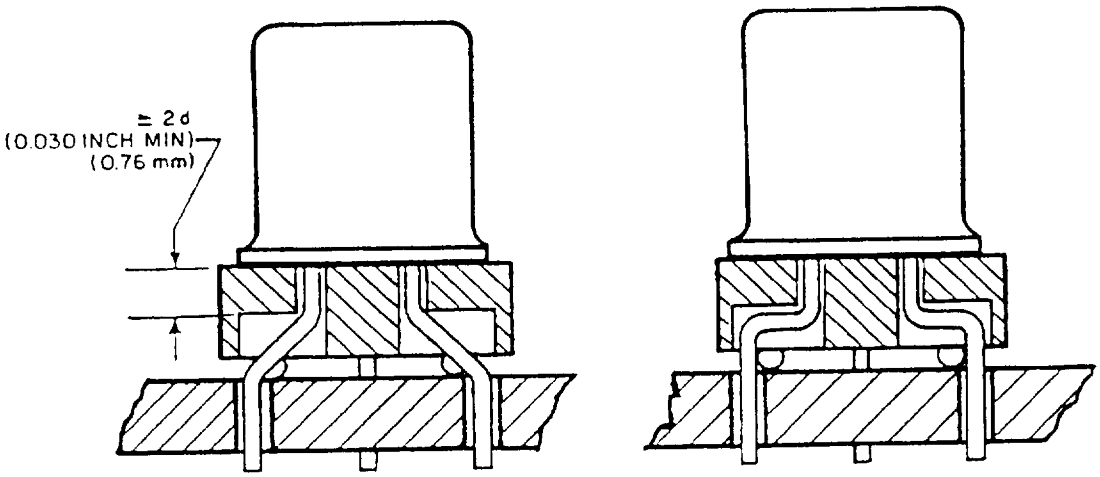


NOT ACCEPTABLE

ALTHOUGH OF RESILIENT MATERIAL, STANDOFF CONCEALS CONNECTION ON COMPONENT SIDE OF BOARD.

F

FIGURE 55. Parallel mounting of nonaxial-leaded components utilizing resilient standoffs (see 5.3.19.9.1.2b).



ACCEPTABLE

BODY SEATED FIRM ON DEVICE.

EACH FOOT IN CONTACT WITH BOARD.

LEAD PROPERLY FORMED IN BEND CAVITY.

A

NOT ACCEPTABLE

LEAD IMPROPERLY FORMED IN BEND CAVITY.

B

FIGURE 56. Parallel mounting of nonaxial-leaded components utilizing nonresilient standoffs (see 5.3.19.9.1.3).

5.3.19.9.1.4 When documented on a government approved assembly drawing a component may be side-mounted as shown in figure 57, and the side surface of the body (or at least one point of any irregularly configured component such as certain pocketbook capacitors) shall be in full contact with the printed board and the body shall be bonded or otherwise retained to the board to preclude hammering when vibrational and shock forces are applied.

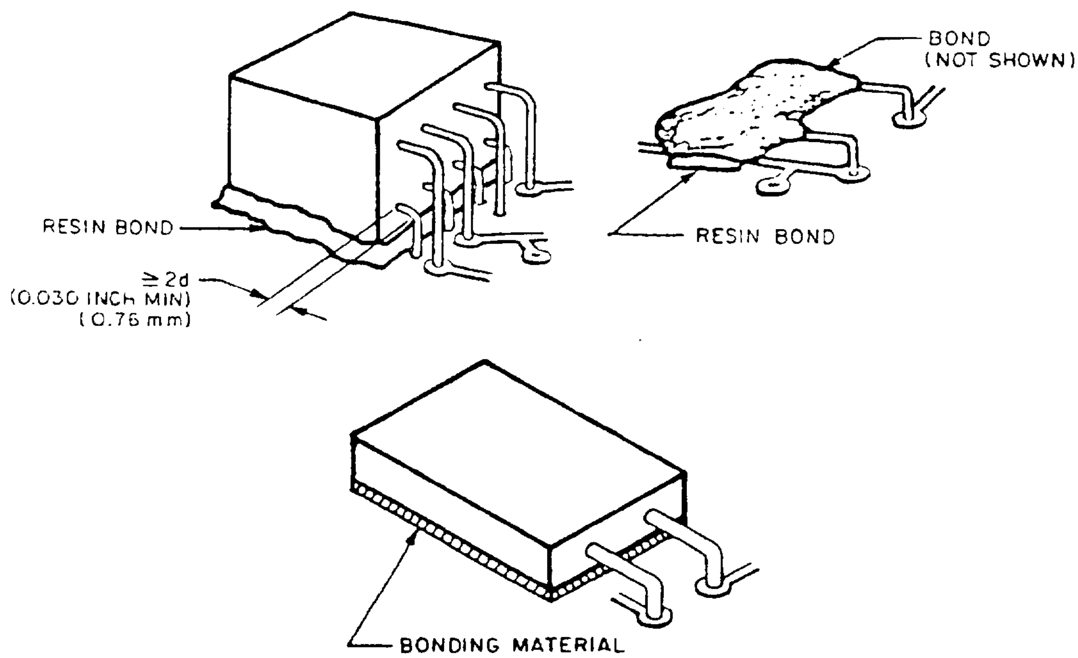


FIGURE 57. Side-mounted, nonaxial-leaded components (see 5.3.19.9.1.4).

5.3.19.9.1.5 When documented on a government approved assembly drawing a component may be side-mounted or end mounted, and leads thereof shall be formed to a radius (r) at least 0.030 inch (0.76 mm) but no less than the diameter (d) of the lead (see figure 62). The maximum radius of any stress relief bend shall be 3d. When leads are formed as shown by phantom lines in figure 58, the span (X) shall not exceed 0.25 inch (6.4 mm). The lead rise (Z) from the base surface of an end mounted component shall not exceed 0.25 inch (6.4 mm). Side-mounted or reverse end-mounted components (figure 58) shall have one side or the reverse end in full contact with the board surface and resin bonded to it.

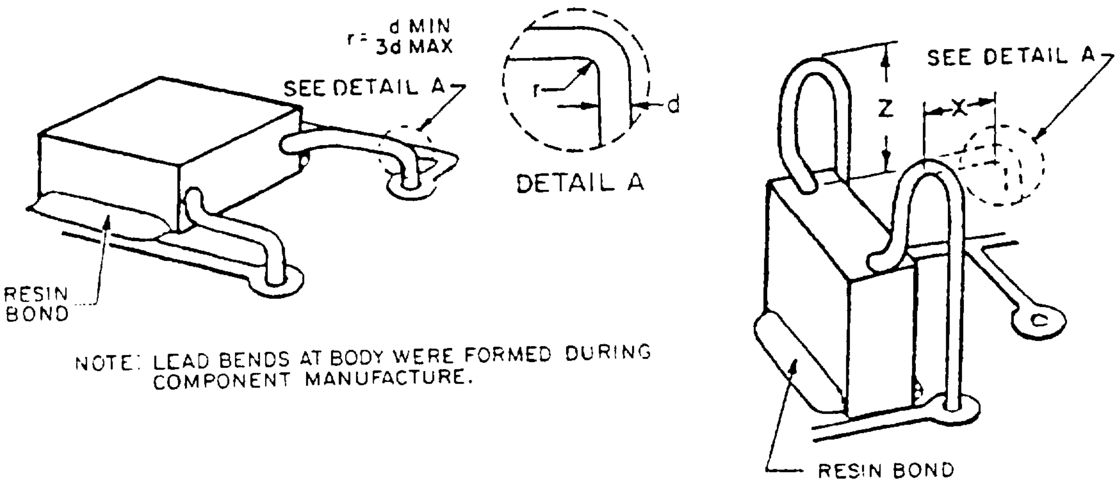


FIGURE 58. Radii for stress relief bends (see 5.3.19.9.1.5).

5.3.19.9.1.6 Any nonaxial-leaded component with coating meniscus on one or more leads shall be mounted such that the meniscus is no closer than 0.010 inch (0.25 mm) from the terminal area on the component surface of the board. Trimming of the meniscus is prohibited. This requirement takes precedence over requirements of 5.3.19.9.1.1 (see figure 59).

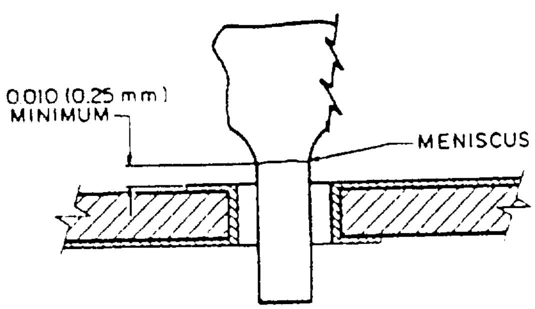


FIGURE 59. Meniscus clearance (see 5.3.19.9.1.6).

5.3.19.9.2 Dual lead components. Dual lead components of configurations A through J of figure 60 shall, as an exception to 5.3.19.9.1.1, be mounted freestanding with the larger sides perpendicular to the board surface ±15 degrees as shown in figure 61 when:

a. Angularity is required for clearance in the next higher assembly.

b. That edge of the body nearest the surface of the board approximately parallels the board surface and is no less than 0.040 inch (1.0 mm) and no more than 0.090 inch (2.3 mm) from the surface.

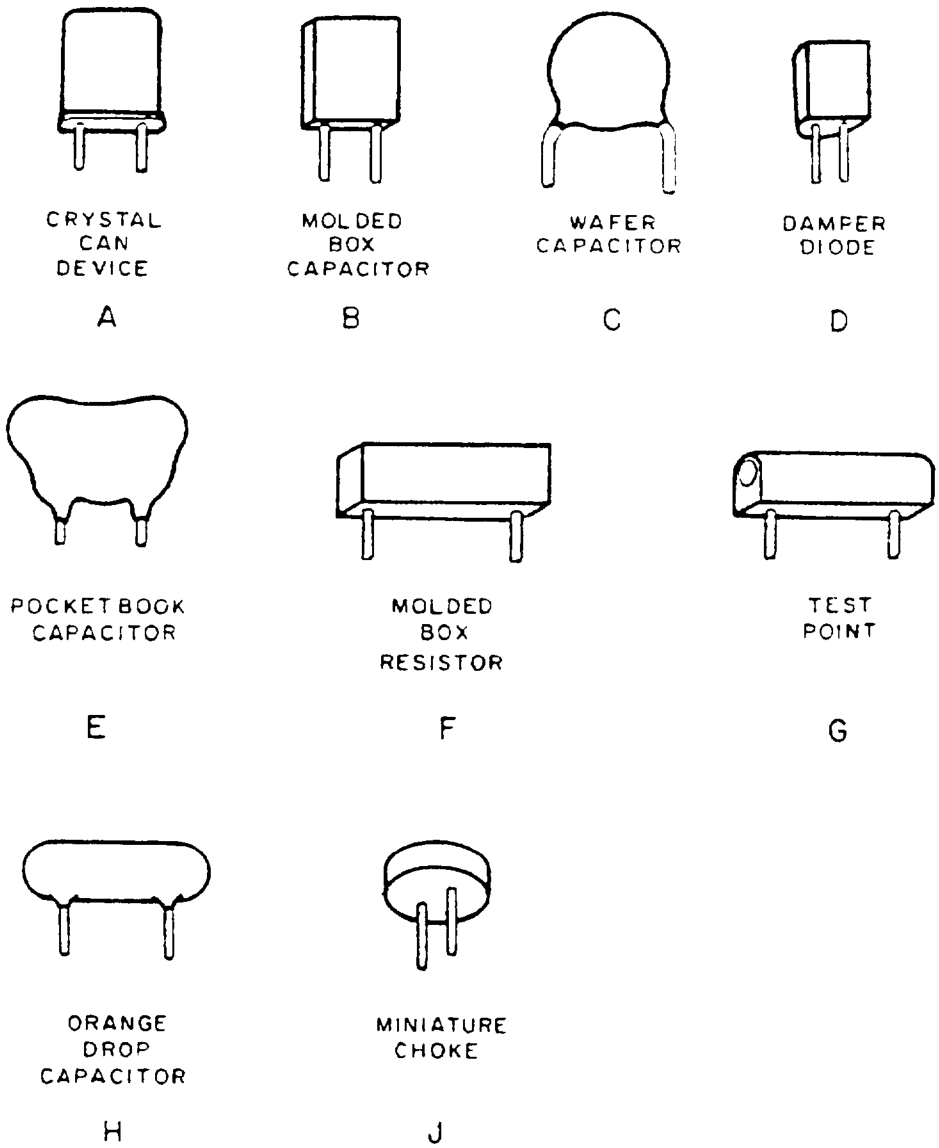


FIGURE 60. Typical configuration of components with dual nonaxial-leads (see 5.3.19.9.2).

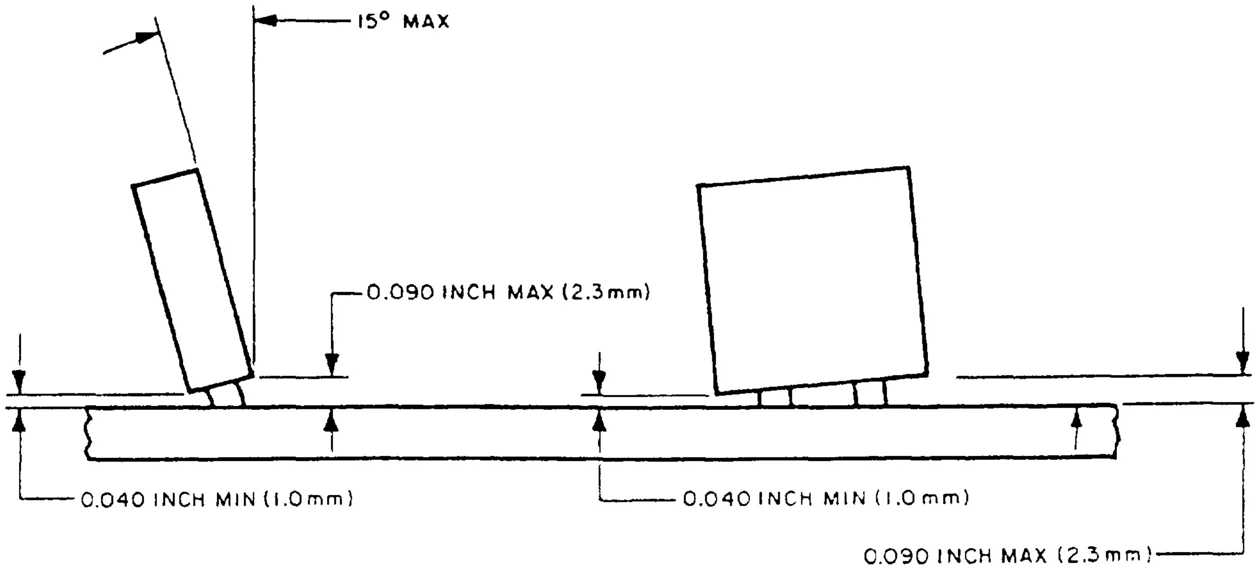


FIGURE 61. Mounting of components with dual nonaxial-leads (see 5.3.19.9.2).

5.3.19.9.3 Metal power packages. As an exception to 5.3.19.9, components of the metal power package configuration (see figure 62) shall not be mounted freestanding. Such components shall be mounted in accordance with paragraph 5.3.19.9.3.1, or, if the leads are neither tempered nor greater than 0.050 inch (1.3 mm) in diameter, and stress relief is provided in accordance with 5.3.19.9.1.5, they may be side-mounted, through-board mounted, or mounted on nonresilient standoffs. The leads of all components of the metal power package configuration shall be stress relieved in accordance with 5.3.19.9, utilizing the stress relief method corresponding to the mounting technique. The standoffs, heat sink frames and resilient spacers on which metal power packages are mounted shall be of a configuration which facilitates cleaning.

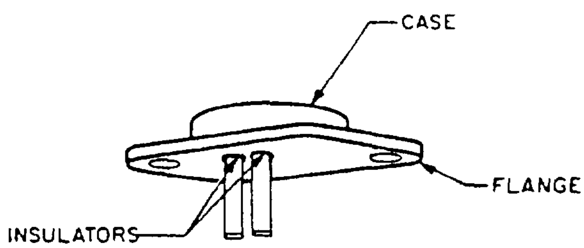


FIGURE 62. Metal power package transistor (see 5.3.19.9.3).

5.3.19.9.3.1 Metal power packages mounted on resilient standoffs. (See figure 63.)

5.3.19.9.3.1.1 Lead holes shall not be plated-through if the component body is mounted in contact with the board or circuitry thereon. This requirement takes precedence over 5.3.19.4.

5.3.19.9.3.1.2 The component body shall be spaced a minimum of 0.020 inch (0.5 mm) above the board surface if lead holes are interfacial or interlayer connections (to permit solder flow to and onto the component terminal areas).

5.3.19.9.3.1.3 Leads may be tempered or exceed 0.050 inch (1.3 mm) provided they are not clinched against the printed wiring terminal area.

5.3.19.9.3.1.4 A washer shall be inserted between each screw head and the terminal area.

5.3.19.9.3.1.5 A washer shall be inserted between each screw head and the board material.

5.3.19.9.3.1.6 Nuts shall be lock type or shall be retained by locking devices.

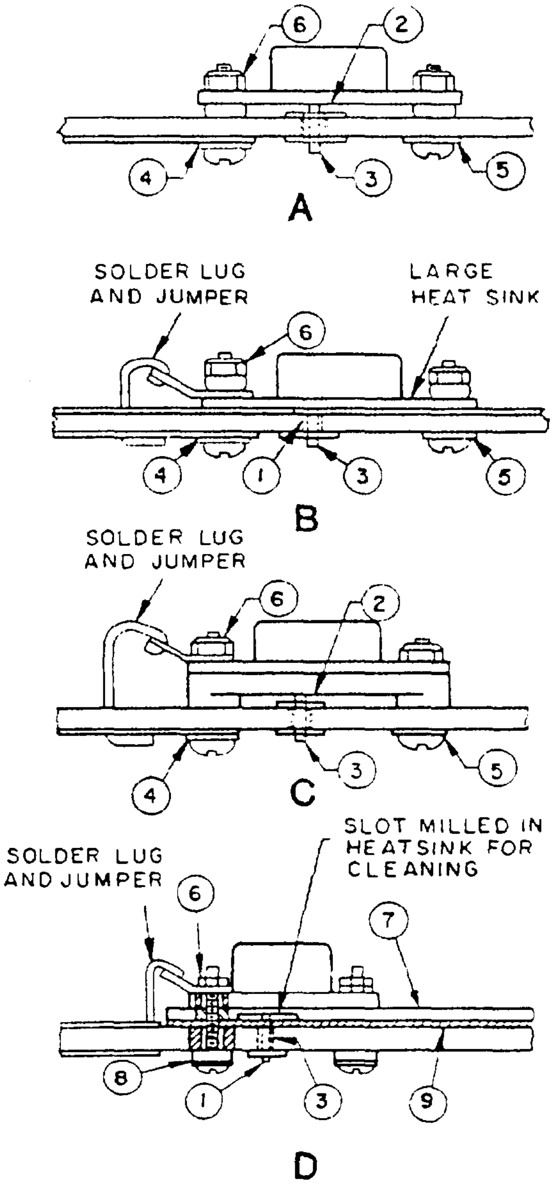
5.3.19.9.3.1.7 The heat sink or device mounting flange must be provided with threads to match the mounting screw for the solder lug.

5.3.19.9.3.1.8 A resilient material shall be incorporated to provide stress relief. It shall either be mounted between the metal power package and the board or be a stressed member in the mounting/hold down hardware (see figure 63D).

5.3.19.9.3.1.9 Where the metal power package or heat sinks are mounted over circuitry, insulating material shall be placed between the metal power package or heat sink and the board.

5.3.19.9.3.1.10 The top side of plated-through holes shall not be obscured and shall allow solder flow onto the component side of the board.

5.3.19.9.3.2 Metal power packages mounted on nonresilient standoffs. The leads of metal power packages mounted on nonresilient standoffs shall be either straight-through in plated-through holes, or clinched in an unsupported hole. The leads shall be untempered or less than 0.050 inch (1.3 mm) in diameter. The leads shall be stress relieved in accordance with 5.3.19.9.1.3. The mounting hardware (screws, nuts, washers, etc.) shall be mounted in accordance with 5.3.19.9.3.1.4 through 5.3.19.9.3.1.7. The insulation and hole clearance requirements of 5.3.19.9.3.1.9 and 5.3.19.9.3.1.10 shall also apply (see figure 63).



(1) Lead holes shall not be plated-through if the component body is mounted in contact with the board or circuitry thereto (see 5.3.19.9.3.1.1).

(2) Component body spaced a minimum of 0.020 inch (0.5 mm) above the board surface (see 5.3.19.9.3.1.2).

(3) Unclinched tempered lead, or lead exceeding 0.050 inch (1.3 mm) in diameter (see 5.3.19.9.3.1.3).

(4) Washer inserted between screw head and the terminal area (to preclude terminal area damage) (see 5.3.19.9.3.1.4).

(5) Washer inserted between screw head and the board material (to preclude board damage).

(6) Lock type nut or nut retained by locking device.

(7) Heat sink or mounting flange provided threaded to match mounting screw.

(8) Resilient material providing stress relief (either mounted between the metal power package and the board or as a stressed member).

(9) Insulating material between metal power package or heat sinks mounted over circuitry.

FIGURE 63. Mounting of metal power packages (see 5.3.19.9.3.1 and 5.3.19.9.3.2).

5.3.19.9.3.3 Heat sinking of metal power packages. Heat sinking frames may be utilized in conjunction with components encased in metal power packages provided mounting is otherwise in accordance with requirements of 5.3.19.9. When heat sinking frames of the type identified as A, B or C of figure 68 are utilized, the preferred method for providing stress relief for solder connections is the inclusion of a resilient spacer between the base of the heat sink and the surface of the printed wiring board. Spacer thickness shall be commensurate with the thickness of the frame and the thickness of the flange of the metal power package but not less than 0.020 inch (0.5 mm) (see figure 64).

NOTE: Heat dissipation characteristics of end-mounted, side-mounted, and through-board mounted components shall be carefully considered for each particular application inasmuch as excess heat can cause damage to printed boards (see 5.3.19.7.1.1) and insufficient dissipation can damage the component internally.

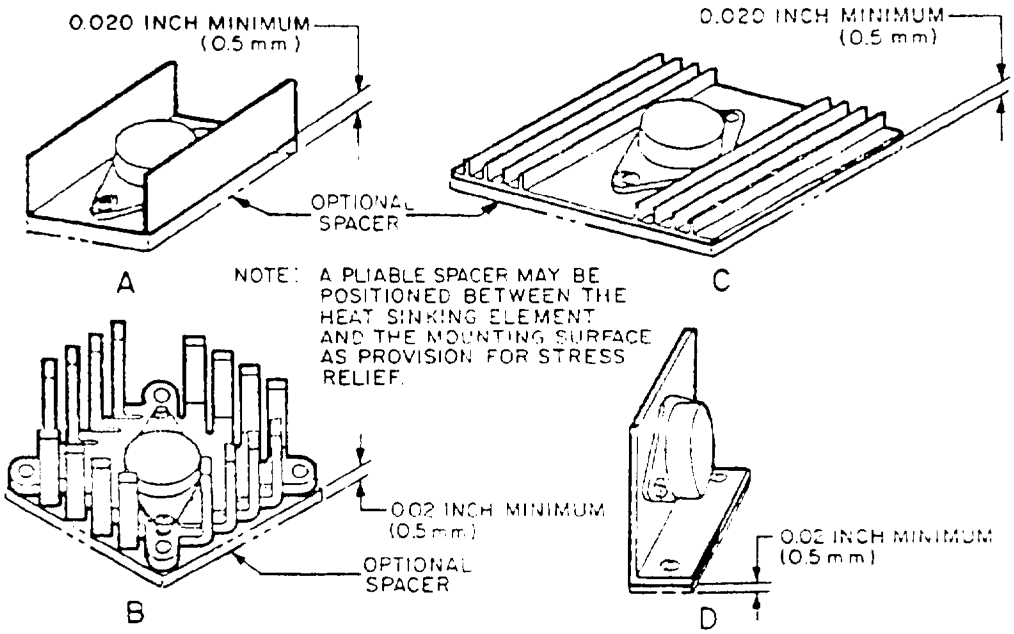


FIGURE 64. Heat sinked metal power packages (see 5.3.19.9.3.3).

5.3.19.9.4 In-line connectors. As an exception to 5.3.19.9, in-line printed wiring board connectors such as shown in figure 65 may be mounted in full contact with the printed wiring board provided that the connector is designed such that there are both stress relief provisions internal to the connector body and cavities (either visible or hidden) which preclude blocking of plated-through holes (see figure 66).

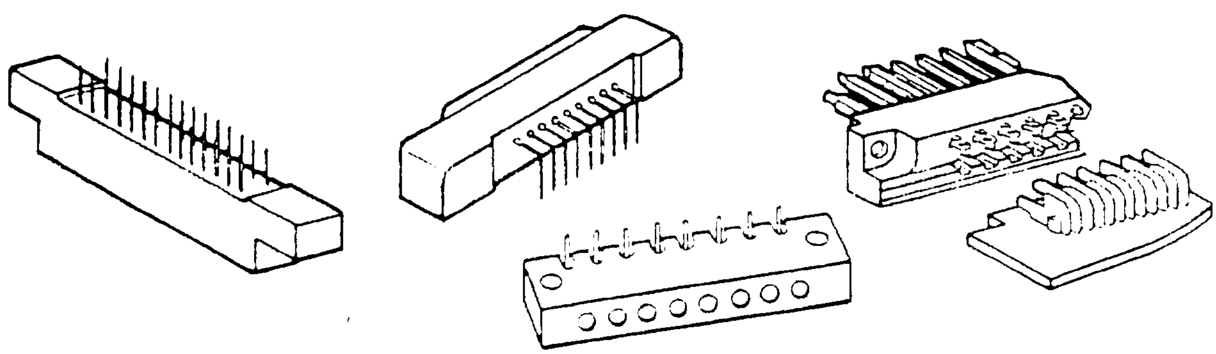


FIGURE 65. In-line printed wiring board connectors (see 5.3.19.9.4).

5.3.19.9.4.1 When internal provision for stress relief and hidden cavities used to facilitate solder flow precludes visual conformance with specified criteria, acceptability of hidden connections shall be based on:

a. Validation that the connector design does include internal provision for stress relief and cavities which permit solder flow.

b. Satisfactory functional characteristics during or after exposure to specified environmental conditions.

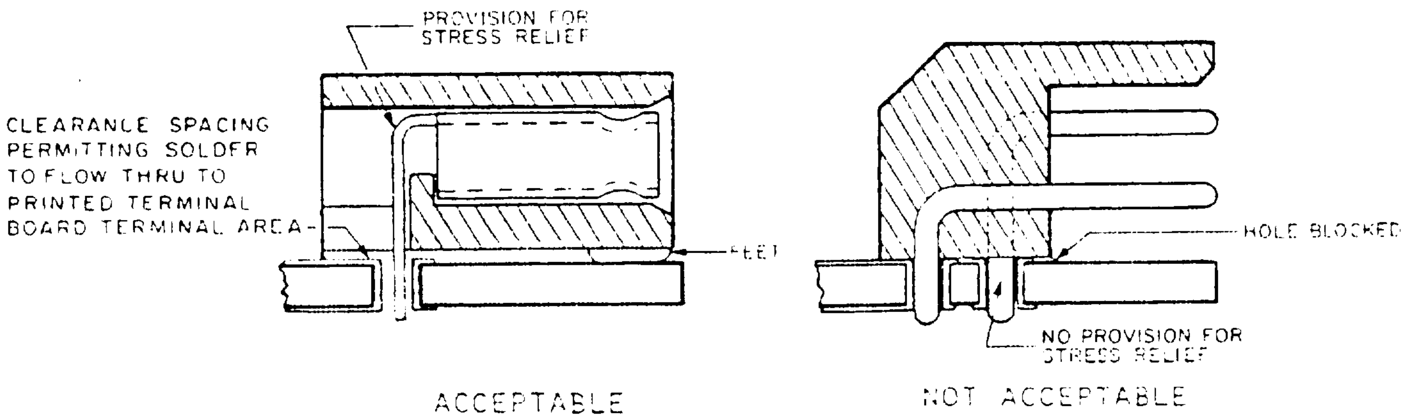


FIGURE 66. Internal connector lead configurations (see 5.3.19.9.4).

5.3.19.9.5 Potentiometers. As an exception to 5.3.19.9.1.1, potentiometers and other adjustment devices weighing less than 1/8 ounce (3.5 grams) per lead shall, unless the diameter of each lead is 0.040 inch (1.0 mm) or greater, be mounted in accordance with 5.3.19.9.1.2 or 5.3.19.9.1.3.

5.3.19.9.6 Tall profile components. As an exception to 5.3.19.9.1.1, tall profile transformers and other devices with center of gravity in the upper half of the component body (see figure 60) shall be mounted in accordance with or 5.3.19.9.1.2 or 5.3.19.9.1.3 regardless of lead diameter or weight per lead ratios.

5.3.19.10 Nonaxial-leaded components with leads extending from more than a single surface. Flatpacks, dual in-line packaged (DIP) components, and other devices configured with leads extended from two or more sidewalls (see figure 67) shall be mounted with all leads seated on terminal areas or in through holes. Leads shall not be truncated (see figure 68). Components of the flatpack configuration shall be mounted in accordance with 5.3.19.10.1 thru 5.3.19.10.4 and those of the DIP configuration shall be mounted in accordance with 5.3.19.10.5.

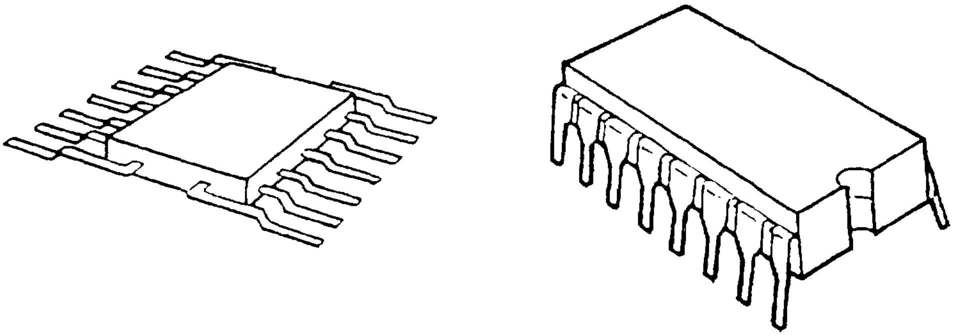


FIGURE 67. Flatpacks and DIPs (see 5.3.19.10).

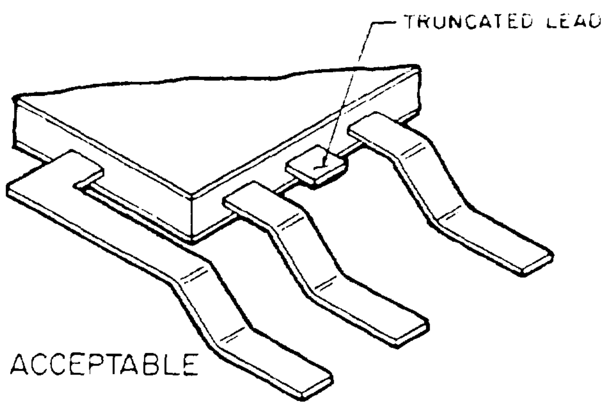


FIGURE 68. Truncated flatpack leads (see 5.3.19.10).

5.3.19.10.1 Flatpacks. Whether planar mounted or mounted with leads inserted in through holes, flatpacks utilized in conjunction with printed wiring assemblies shall be mounted in accordance with 5.3.19.10.1.1.

5.3.19.10.1.1 Body seating. Flatpacks shall be mounted with the body seated in accordance with 5.3.19.10.1.2 thru 5.3.19.10.1.6.

5.3.19.10.1.2 Any component with a body of non-conductive material shall be mounted with the body seated in contact with the surface of the printed board or circuitry thereof unless; the terminal area pattern of the device is such that the portion of the terminal area abutting any plated through hole used for interfacial or connection is partially or totally beneath the body (see figure 69).

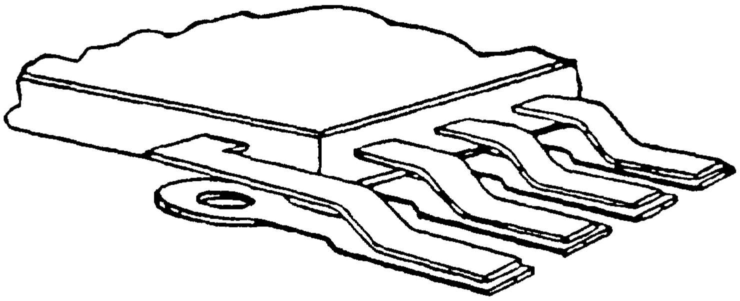


FIGURE 69. Flatpack seated on printed pattern combined with interfacial hole (see 5.3.19.10.1.2).

5.3.19.10.1.3 Any component with a body of conductive material shall be seated on the printed board only if there is no printed conductor beneath the body.

5.3.19.10.1.4 If there are one or more conductors beneath a conductive body, or, if a body is nonconductive but covers more than one printed conductor on a board, the body shall be:

a. Mounted flat on electrical insulation that is firmly affixed (either by pressure or adhesive) to the printed board such that the moisture traps are precluded; or

b. Spaced from the board a minimum of 0.015 inch (0.38 mm).

5.3.19.10.1.5 If the terminal area pattern for the flatpack is such that any interlayer portion of the area surrounding a plated-through hole used for interfacial or interlayer connection underlies either a conductive or non-conductive body, the body shall be spaced a minimum of 0.015 inch (0.38 mm) above the surface of the terminal area to permit solder flow through the hole onto the terminal area.

5.3.19.10.1.6 Maximum spacing between the component body and the surface of the terminal area shall be 0.040 inch (1.0 mm).

5.3.19.10.1.7 Leads on opposite sides of planar mounted flat packs (see figure 70) shall be formed such that component cant (non-parallelism between the base surface of the mounted component and the surface of the printed wiring board) is minimal and in no instance shall body cant result in non-conformance with the minimum and maximum spacing limits 0.015 inch (0.38 mm) and 0.040 inch (1.0 mm), respectively) as specified in 5.3.19.10.1.5 and 5.3.19.10.1.6.

5.3.19.10.2 Lead configuration. Leads of flatpacks of the plug-in configuration (leads egressing from the base surface as shown in figure 70) shall be configured for mounting in accordance with 5.3.19.9.1.1 and the component shall be mounted in accordance with the requirements thereof. Whether of the ribbon, flatted or square configuration, the leads of flatpacks of the normal and butterfly configuration (leads egressing from two or more sidewalls as shown in figure 71) shall be configured as shown in figure 72 if the component is planar mounted and as shown in figure 73 if mounted with leads dressed through the board.

FIGURE 70. Flatpacks of the plug-in configuration (see 5.3.19.10.2)

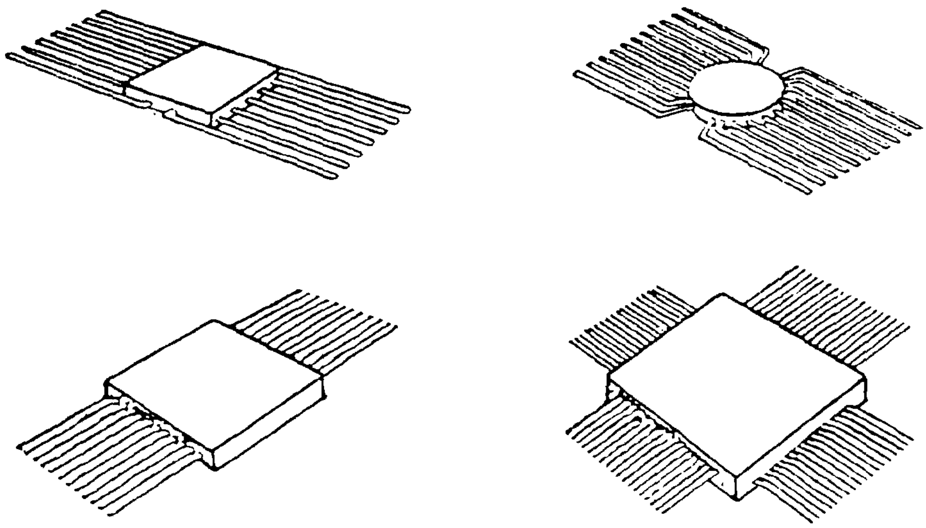


FIGURE 71. Normal and butterfly flatpacks (see 5.3.19.10.2).

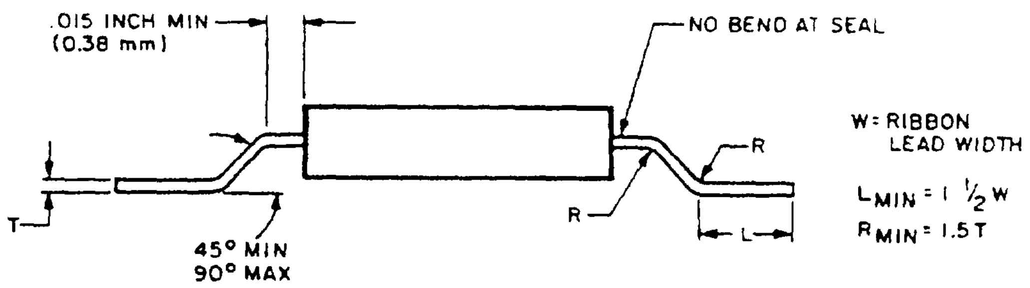


FIGURE 72. Configuration of ribbon leads for planar mounted flatpacks (see 5.3.19.10.2).

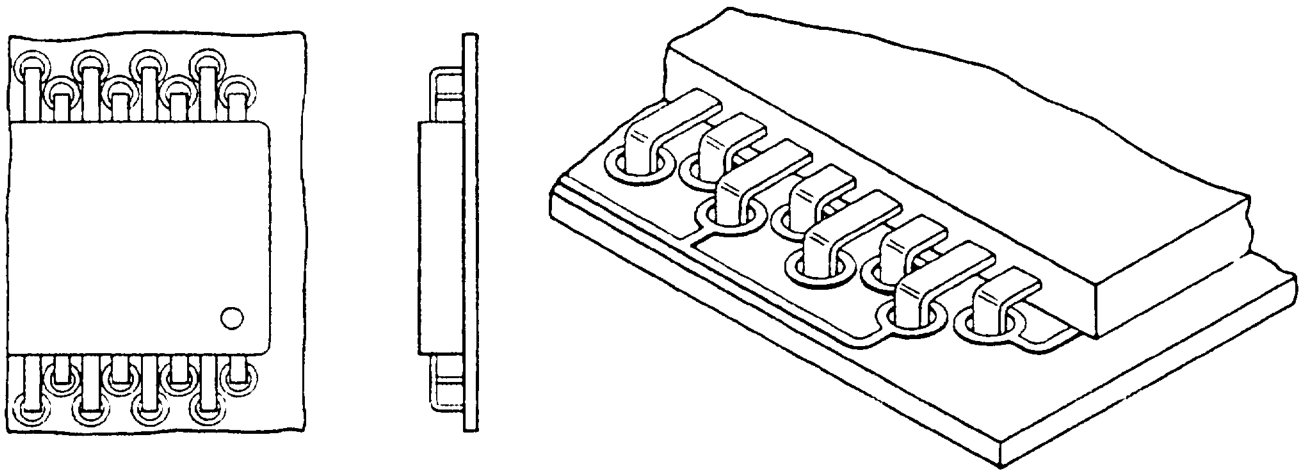


FIGURE 73. Configuration of ribbon leads for through-hole mounted flatpacks (see 5.3.19.10.2).

5.3.19.10.3 Lead seating for planar mounted flatpacks. Leads shall be seated such that the heel to terminal area relationship shall conform to figure 74. Leads shall be seated such that there is no side overhang. Toe overhang (see figures 74 and 75) is acceptable provided that the requirements of 5.3.19.10.3.1 through 5.3.19.10.3.6 are met.

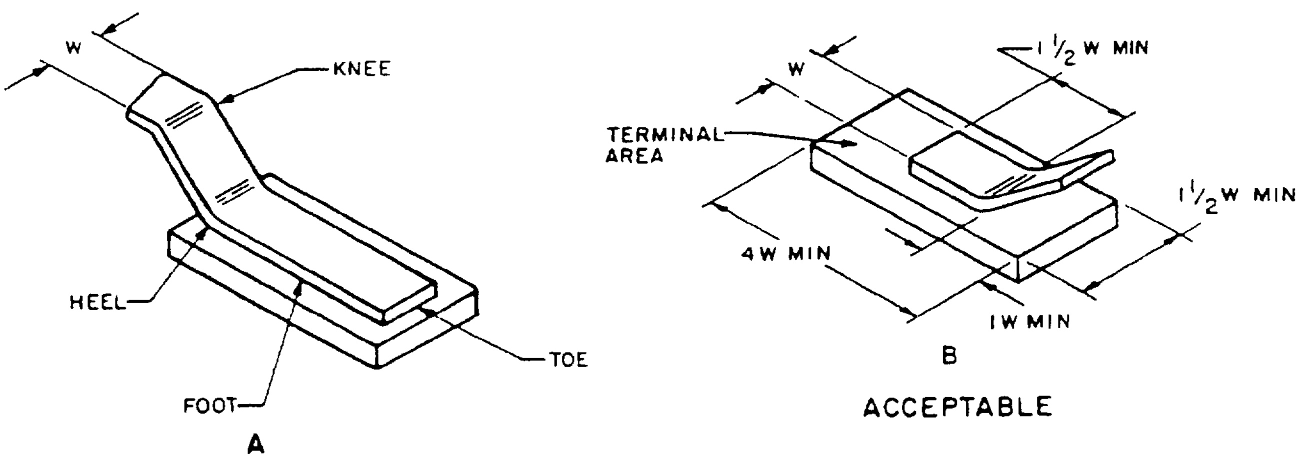


FIGURE 74. Heel mounting requirements for ribbon leads (see 5.3.19.10.3).

5.3.19.10.3.1 The length of lead contact shall be a minimum of 150 percent of the width (see figures 74 and 75).

5.3.19.10.3.2 Toe overhang is permissible provided that it does not exceed 25 percent of the width or diameter of the lead and the spacing to adjacent conductive elements remains greater than the minimums specified in paragraphs 5.3.2 and 5.3.3 (see figure 75).

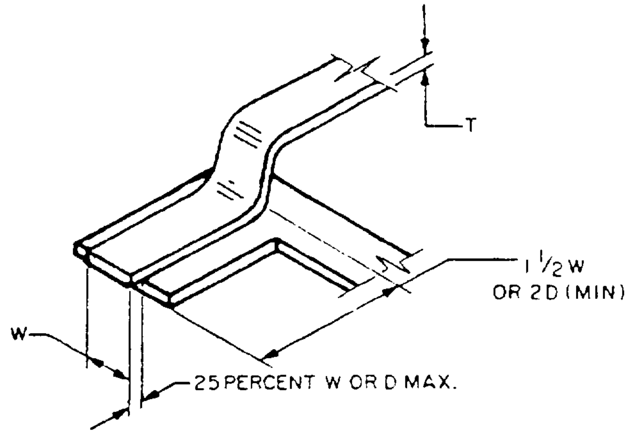


FIGURE 75. Toe overhang limits for ribbon leads (see 5.3.24.19.3 and 5.3.19.10.3.2).

5.3.19.10.3.3 Toe curl shall not exceed twice the lead thickness (2T) (see figure 76).

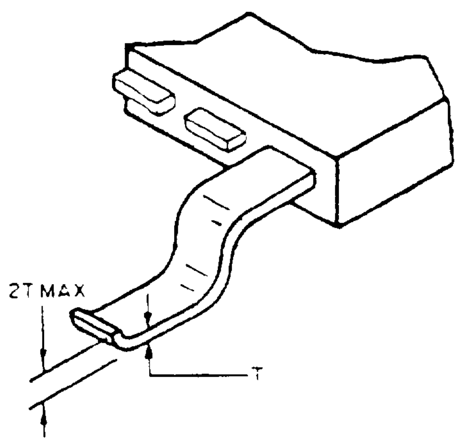


FIGURE 76. Toe curl limits for ribbon leads (see 5.3.19.10.3 and 5.3.19.10.3.3).

5.3.19.10.3.4 It is preferred that leads be seated in contact with the terminal area for the full length of the foot. Separation between the foot of such leads and the surface of the terminal associated area shall not exceed twice the lead thickness (2T) (see figure 77).

5.3.19.10.3.5 Leads shall be formed such that they will contact the termination area upon mounting without the need to impart stress on the lead to accomplish soldering.

5.3.19.10.3.6 Leads shall be formed such that foot twist is minimal and in no instance shall foot twist result in non-conformance with the 2T maximum spacing requirement of 5.3.19.10.3.4.

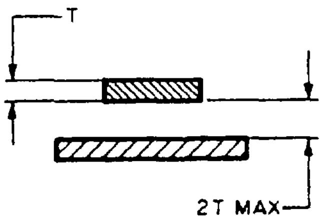


FIGURE 77. Permissible separation between lead and terminal area (see 5.3.19.10.3.4).

5.3.19.10.4 Lead dressed for through-board mounting. Whether of a round, square or ribbon cross section, leads shall be dressed to and through the printed wiring board such that canting, bending, bowing, twisting, or other deformation does not cause clearance spacings to be reduced beyond the minimum specified (see 5.3.2). Canting, bowing and bending of leads in any direction shall not exceed 25 percent of the lead width (or diameter) nor shall leads be twisted more than 15 degrees.

5.3.19.10.5 Dual in-line packages. A dual in-line package (DIP) utilized in conjunction with printed wiring assemblies shall be mounted in accordance with 5.3.19.10.5.1 thru 5.3.19.10.5.8.

5.3.19.10.5.1 The base of the device shall be spaced from the surface of the printed wiring board a minimum of 0.010 inch (0.25 mm) and a maximum of 0.060 inch (1.1 mm).

5.3.19.10.5.2 When a separate resilient footed or nonfooted standoff is utilized in conjunction with a dual inline package, mounting shall be in accordance with 5.3.19.9.1.2. Standoffs shall be mounted in contact with the component and the printed wiring board (see figure 78).

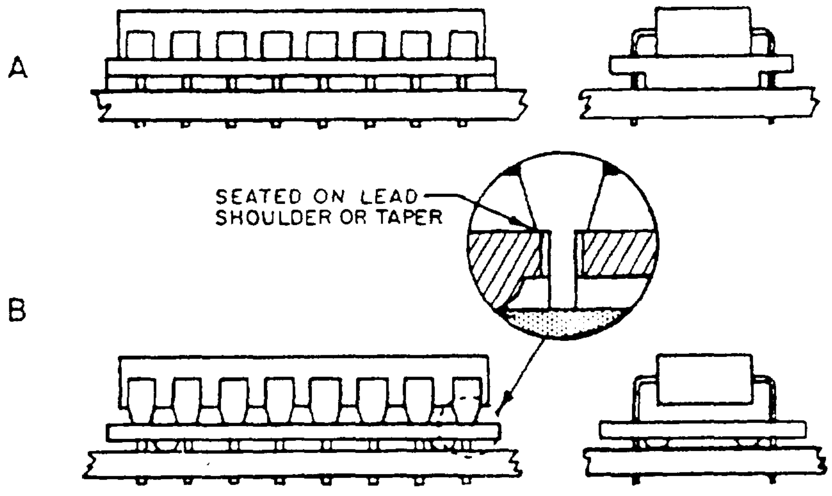


FIGURE 78. DIP mounting utilizing resilient footed and nonfooted standoffs (see 5.3.19.10.5.2).

5.3.19.10.5.3 DIP devices shall not be mounted in sockets or other plugin devices which rely upon contact pressure for part retention. Leads of the DIP device shall be soldered in place.

5.3.19.10.5.4 DIPs mounted directly to heat sink frames shall have special stress relief provisions included. The use of heat sink frames must comply with the hole obstruction requirements of 5.3.19.1.

NOTE: The inclusion of a pliable spacer material between the heat sink frame and the printed wiring board (see figure 79A, 79B and 79C) is an acceptable method for assuring stress relief provided the resilient added material is of sufficient thickness (0.020 inch (0.5 mm) typical) to compensate for forces imposed during temperature change.

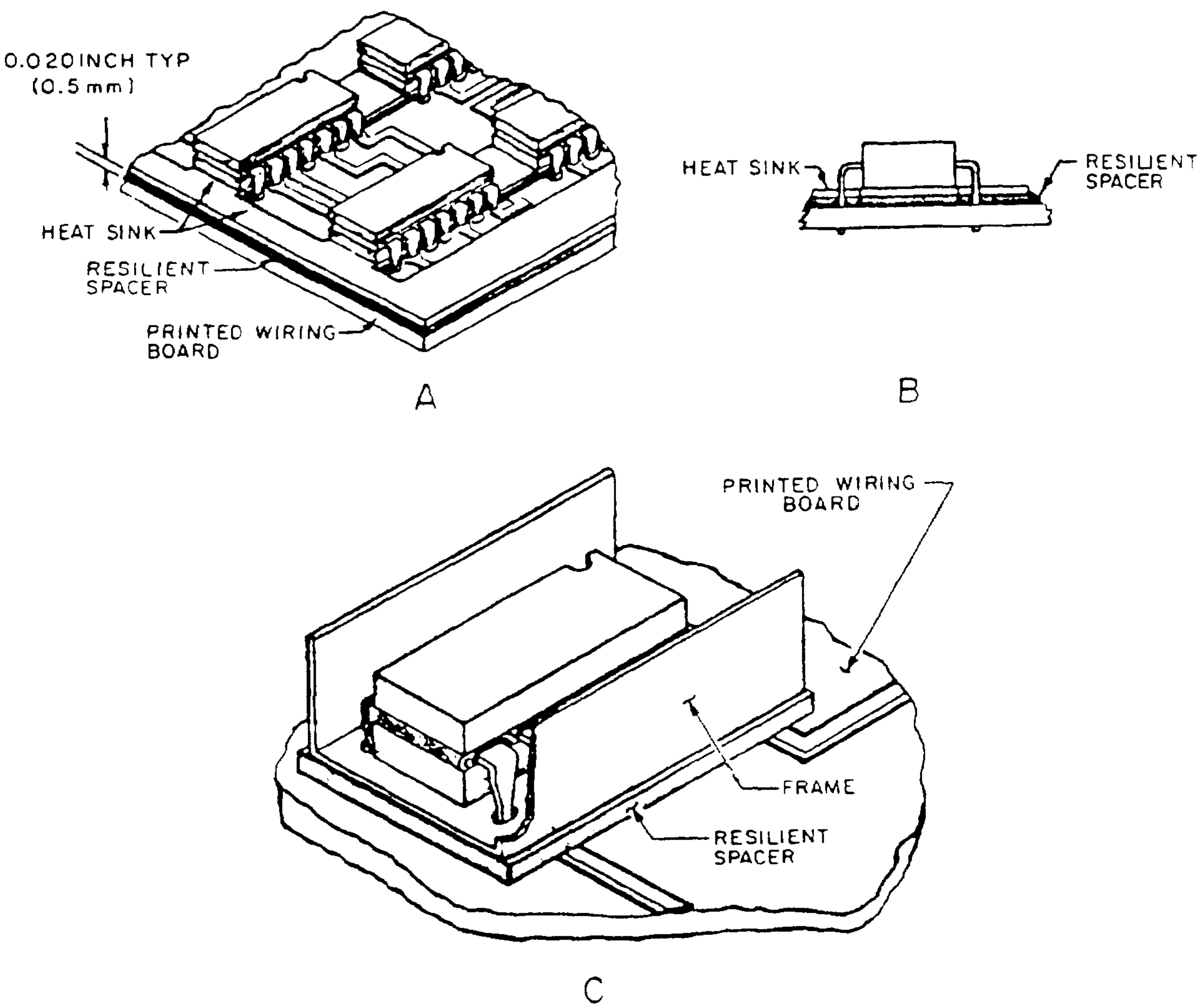


FIGURE 79. Resilient spacer to heat sink frame (see 5.3.19.10.5.4).

5.3.19.10.5.5 The body of a DIP device shall not be formed from epoxy, other resin, or plastic. CERDIPs and ceramic bodied DIPs with side brazed leads are acceptable provided they are proven reliable for intended environmental use (see figure 80A and 80B).

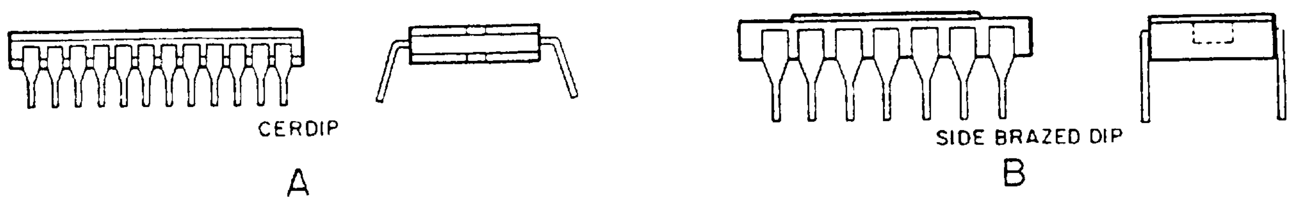


FIGURE 80. Typical ceramic dual in-line package devices (see 5.3.19.10.5.5).

5.3.19.10.5.6 Leads on DIPs may be bent, rather than clinched, toward the termination area to retain parts during soldering operations but shall conform to the protrusion requirements of 5.3.19.4.1 (see figure 81). Bends shall be limited by the requirements of 5.3.19.4.1 with the direction outward (away from the center of the part body). Alternate bend directions may be used when specified on the government approved assembly drawing.

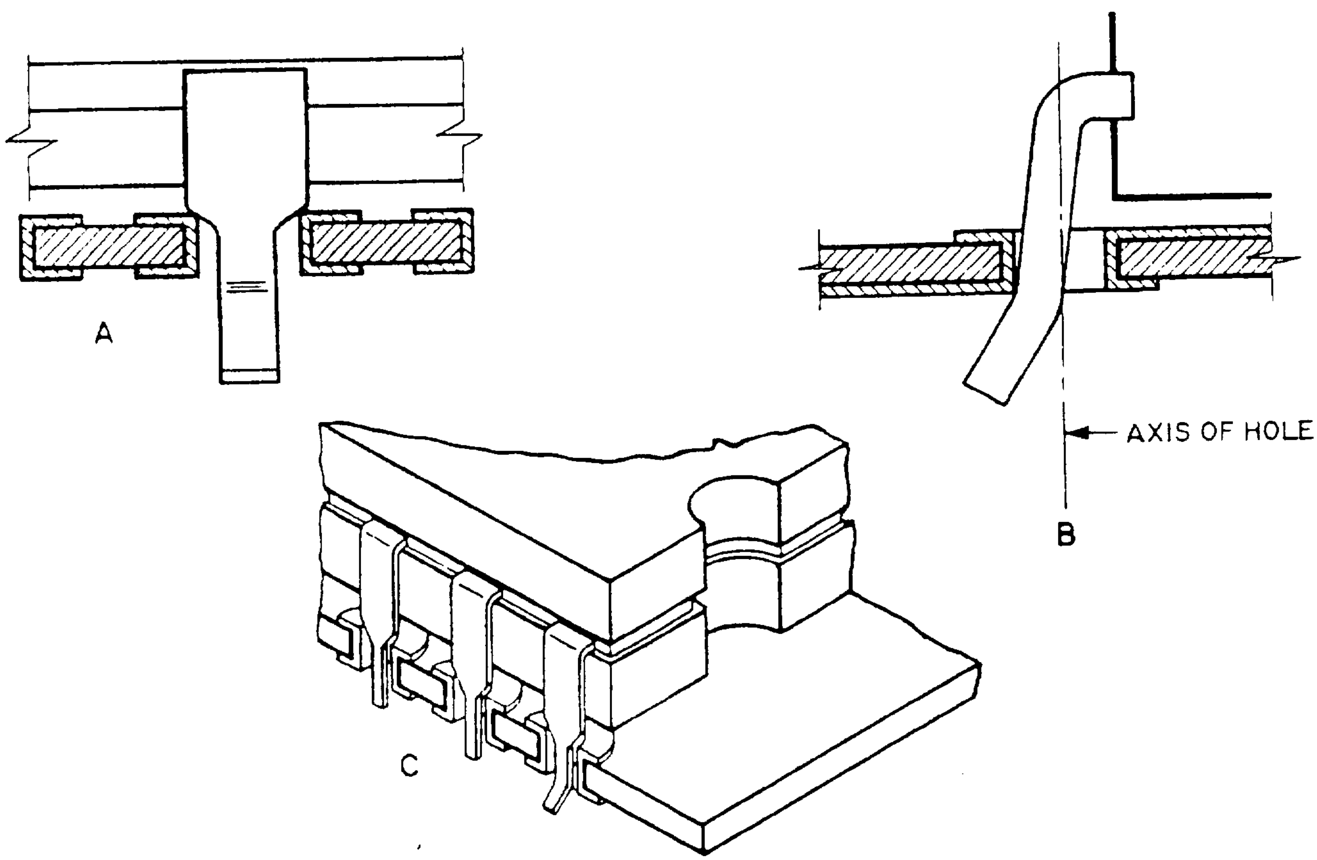


FIGURE 81. Lead bends for multileaded components (see 5.3.19.10.5.6).

5.3.19.10.5.7 The lead-to-body seals of mounted devices shall be undamaged except for menisus cracks located within 1/2 the distance from the lead to the case. Hairline cracks in either the seal or the body are not acceptable (see figure 82).

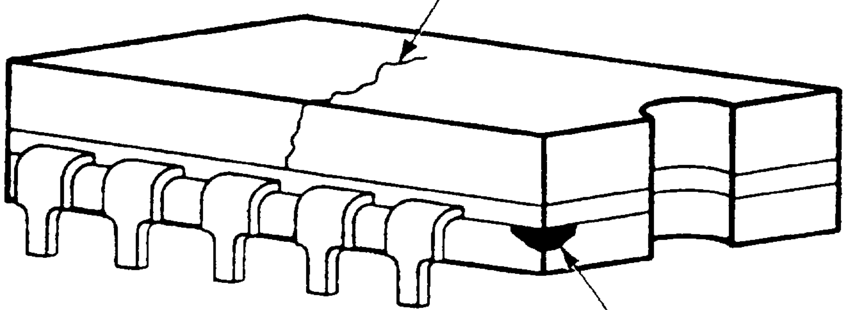


FIGURE 82. Not acceptable body and seal conditions (see 5.3.19.10.7).

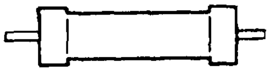
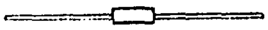
5.3.19.11 Planar mounted components. Except as specified in 5.3.19.11.1 and 5.3.19.11.2, components shall be planar mounted only when documented on a government approved assembly drawing.

5.3.19.11.1 Flatpacks of the plug-in configuration, dual in-line packages, transistors, metal power packages, and other nonaxial-leaded components shall not be planar mounted.

5.3.19.11.2 Miniature axial-leaded components. Miniature axial-leaded components shall be planar mounted in accordance with 5.3.19.11.2.1 thru 5.3.19.11.2.6.

5.3.19.11.2.1 Planar mounting of axial-leaded component shall be utilized only if the component is miniature, weighing less than .050 ounces (1.4 grams), and is mounted parallel to the board surface. Table X lists the weight and body diameter of typical axial-leaded resistors.

TABLE X. Approximate weight of typical resistors.

Power Rating (Watts)	Physical Configuration	Body Dia.		Weight	
		Inches	mm	Ounces	Grams
5		0.30	7.6	0.143	4.05
2		0.31	7.9	0.101	2.86
1		0.28	7.1	0.052	1.49
1/2		0.14	3.6	0.022	0.62
1/4		0.10	2.5	0.011	0.31
1/4		0.09	2.3	0.010	0.28
1/8		0.06	1.5	0.003	0.08

NOTE: The size and weight of components vary by type of component, material, construction, manufacturer and other like considerations. Accordingly, the characteristics of a component to be planar lead mounted should be ascertained on an individual piece basis.

5.3.19.11.2.2 Components with axial-leads of rectangular cross section shall be mounted in accordance with 5.3.19.10.3.

5.3.19.11.2.3 Components with axial-leads of round cross section may be coined or flattened for positive seating in planar mounting. If coining or flattening is used, the following applies:

a. For flattened round leads with an original diameter (D) of 0.025 inch (0.64 mm) or greater, the flattened thickness (T) shall be 60 ± 10% of the original diameter.

b. For leads with an original diameter of less than 0.025 inch (0.64 mm), the flattened thickness shall be 50 ± 5% of the original diameter (see figure 83).

Actual measurement of the flattened thickness is not required except for referee purposes. Flattened areas of leads coined for planar mounting shall be excluded from the 10 percent deformation requirement.

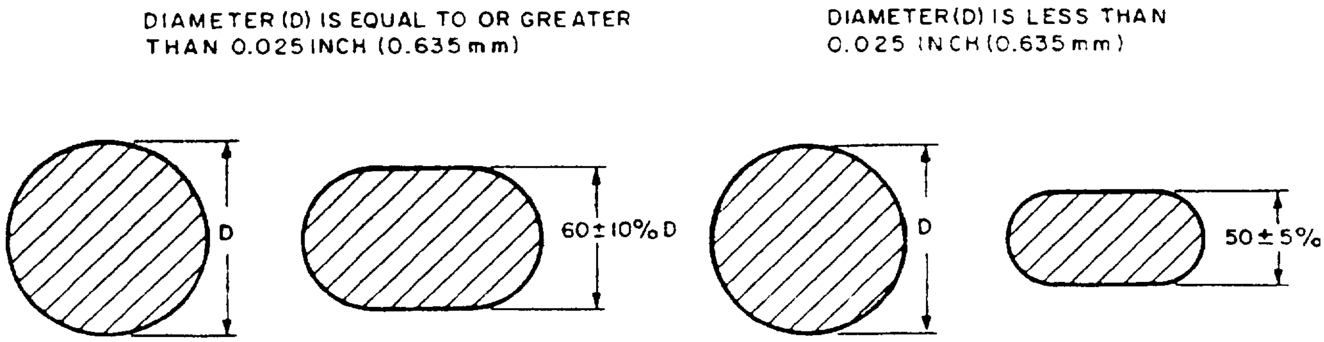


FIGURE 83. Flattened round leads (see 5.3.19.11.2.3).

5.3.19.11.2.4 The body of a planar mounted axial-leaded component shall be spaced a minimum of 0.015 inch (0.38 mm) from the surface of the printed wiring board and a maximum of 0.025 inch (0.64 mm) (see figure 84). Leads on opposite sides of planar mounted axial-leaded components shall be formed such that component cant (nonparallelism between the base surface of the mounted component and the surface of the printed wiring board) is minimal and in no instance shall body cant result in nonconformance with the minimum and maximum spacing limits (0.015 inch (0.38 mm) and 0.025 inch (0.64 mm), respectively).

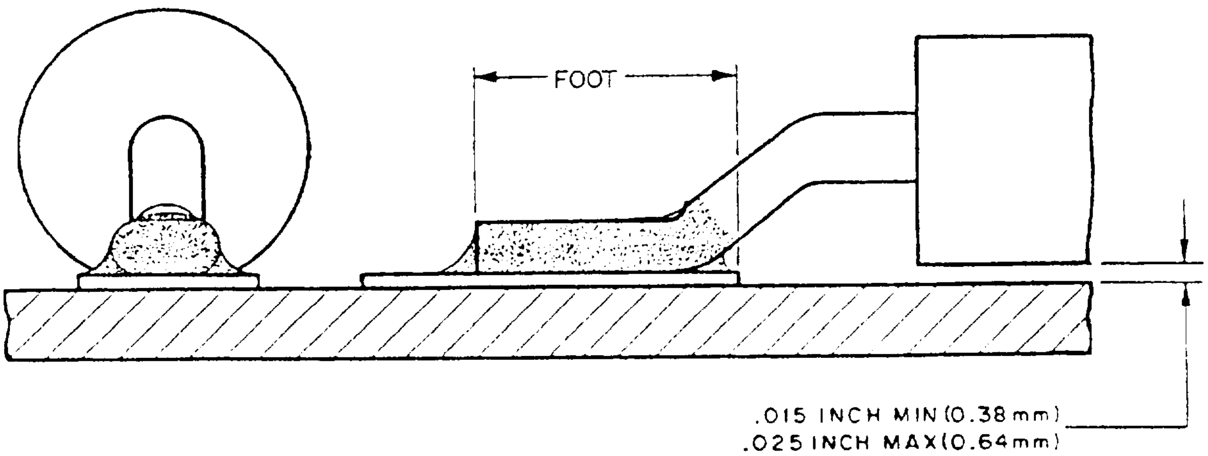


FIGURE 84. Coined or flattened lead (see 5.3.19.11.2.4 and 5.3.19.11.2.5).

5.3.19.11.2.5 Round or flattened (coined) leads shall be seated with the heel to terminal area relationship in accordance with figure 74. Leads shall be seated with no side overhang. Toe overhang is acceptable provided that the flattened lead in contact with the terminal area is a minimum of 150 percent of the unflattened lead diameter and the overhang does not reduce spacing to adjacent parts to less than specified in 5.3.2 and 5.3.3.

5.3.19.11.2.6 It is preferred that leads be seated in contact with the terminal area for the full length of the foot. Separation between the foot of such leads and the surface of the terminal area shall be limited to 15 degrees from the surface of the board (see figure 85).

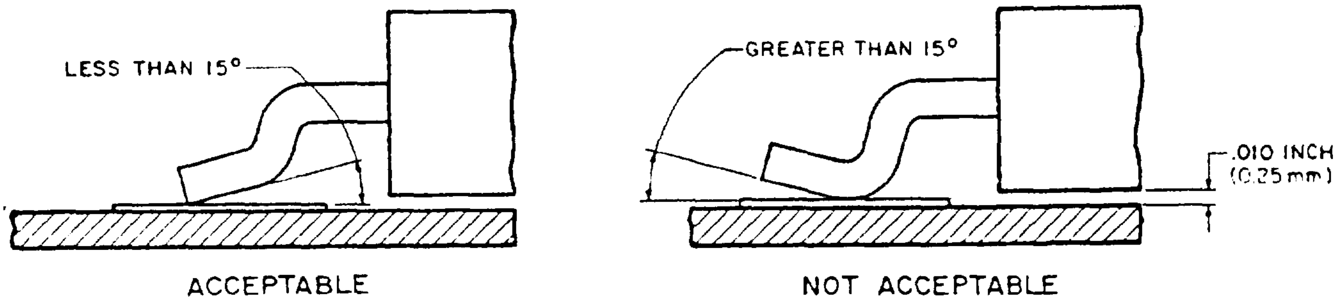


FIGURE 85. Formed lead alignment (see 5.3.19.11.2.6).

5.3.19.12 Terminals used for mechanical mounting. Terminals not connected to printed wiring or printed ground planes shall be of the rolled flange configuration (see figure 86). Rolled flange terminals shall be in accordance with 5.3.19.12.1 thru 5.3.19.12.5.

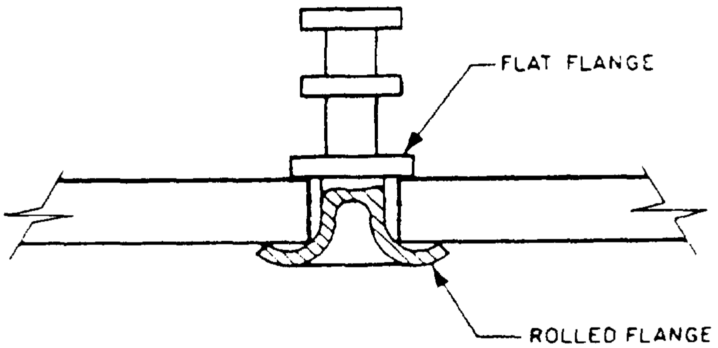


FIGURE 86. Rolled flange terminals (see 5.3.19.12).

5.3.19.12.1 The terminal shall be set such that it can neither be rotated nor moved axially under normal finger force and such that there is no cracking, chipping, or delamination of the base material of the printed board or terminal board.

5.3.19.12.2 The shank of the terminal shall not be perforated nor split, cracked, or otherwise discontinuous to the extent that oils, flux, inks, or other liquid substances utilized for processing the printed board are or can be entrapped within the mounting hole. Circumferential cracks or splits in the shank are not acceptable regardless of extent.

5.3.19.12.3 The lip of the rolled flange shall contact the base laminate for the full periphery of the flange.

5.3.19.12.4 The rolled flange shall not be split, cracked, or otherwise discontinuous to the extent that flux, oils, inks, or other liquid substances utilized for processing the printed board can be entrapped within the mounting hole. After rolling, the rolled area shall be free of circumferential splits or cracks, but may have a maximum of three radial splits or cracks provided that the splits or cracks are separated by at least 90 degrees and do not extend beyond the rolled area of the terminal (see figure 87).

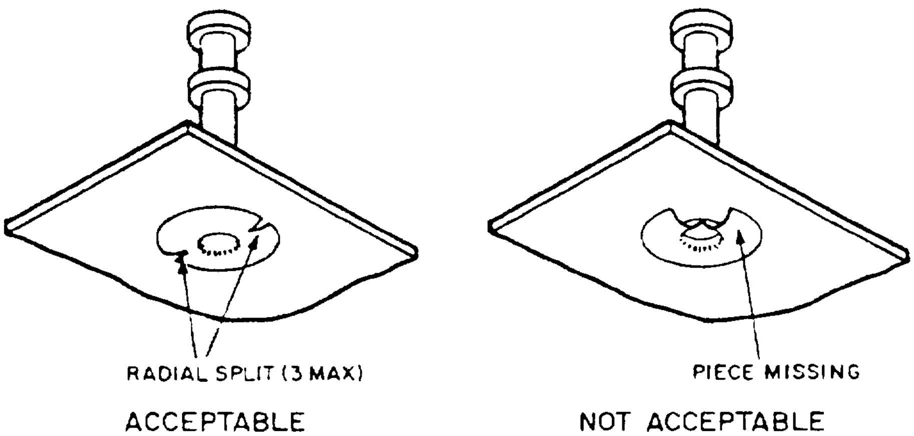


FIGURE 87. Rolled flange requirement (see 5.3.19.12.4).

5.3.19.12.5 Washers or discs may be utilized under the rolled flanges provided that:

a. There are no deviations from other requirements of this paragraph.

b. The washer or discs are not utilized for connection to electrical circuitry either by pressure or direct wiring.

5.3.19.12.6 A printed foil pad may be utilized as a seating surface for a rolled flange provided that the pad is isolated and not connected to active printed wiring or ground plane.

NOTE: When a rolled flange is used in conjunction with an electrically nonactive pad, solder is neither necessary nor particularly desirable.

5.3.19.13 Terminals used for electrical mounting. The flared flange terminal configuration (figure 88) shall be used for printed boards or printed board assemblies. The funnel flange terminals configuration (figure 88) shall be utilized only in conjunction with terminal areas (isolated or active) or ground planes; they shall not be flared to the base material of the printed board. Terminals shall be mounted in accordance with 5.3.19.13.1 thru 5.3.19.13.7.

5.3.19.13.1 The terminal shall be approximately perpendicular to the board surface.

5.3.19.13.2 Flat body flanges (see figure 88) shall be seated to the base material of the printed board and not on ground planes or terminal areas except as permitted in 5.3.19.13.6.

5.3.19.13.3 The installed terminal shall be free to rotate, but not free to move axially under normal finger force. Magnification aids are not required to check the axial movement.

5.3.19.13.4 Flared flanges shall be formed to an included angle between 55 and 120 degrees and shall extend between 0.015 inch (0.38 mm) and 0.060 inch (1.5 mm) beyond the surface of the terminal area provided minimum electrical spacing requirements are maintained (see figure 89) and the flare diameter does not exceed the diameter of the terminal land area.

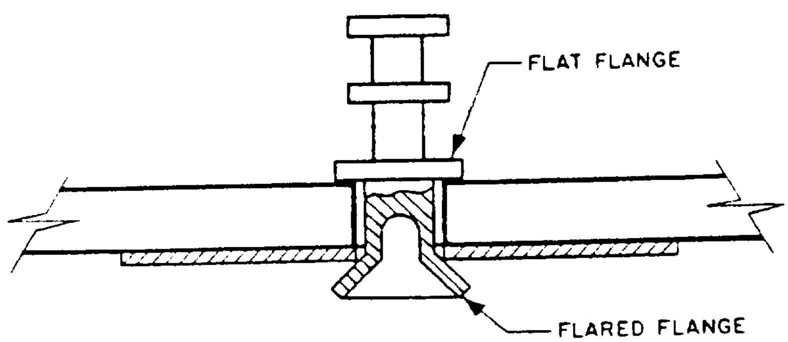


FIGURE 88. Standoff termination (see 5.3.19.13).

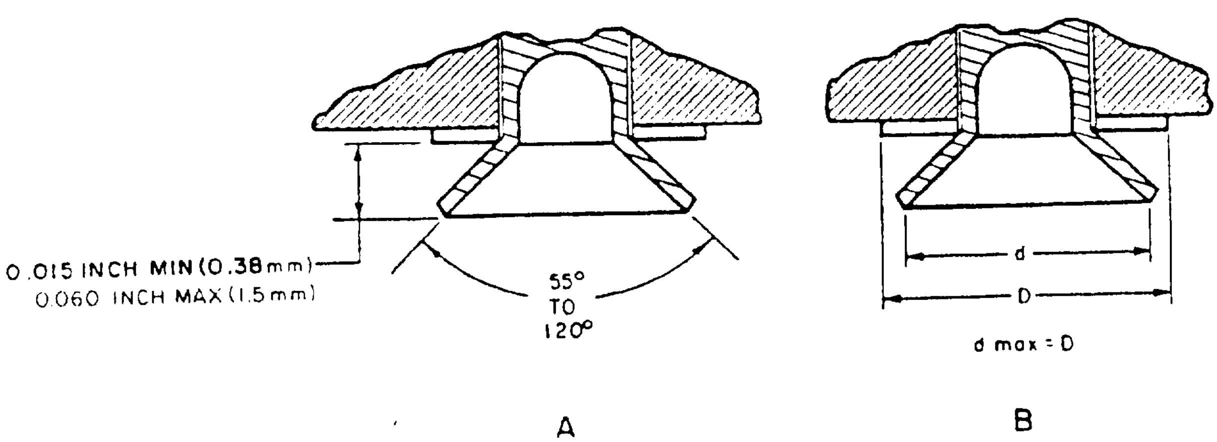


FIGURE 89. Flare and extension of funnel flanges (see 5.3.19.13.4 and 5.3.19.13.5).

5.3.19.13.5 The flared flange of a terminal shall not be perforated or split, cracked, or otherwise discontinuous to the extent that oils, flux, inks, or other liquid substances utilized for processing the printed board may be entrapped within the mounting hole. After flaring, the flange shall be free of circumferential splits or cracks, but may have a maximum of three radial splits or cracks provided that the splits or cracks are separated by at least 90 degrees and do not extend beyond the flared area of the terminal.

5.3.19.13.6 Terminals shall only be mounted in unsupported holes. If it is essential that a terminal be utilized for interfacial connection, a dual hole configuration incorporating a supported plated-through hole shall be combined with an unsupported hole interconnected by a terminal area on the solder side of the printed wiring board (see figure 90). As an exception, the terminal may be mounted in a plated through hole with a nonfunctional land on the component side (see figure 91).

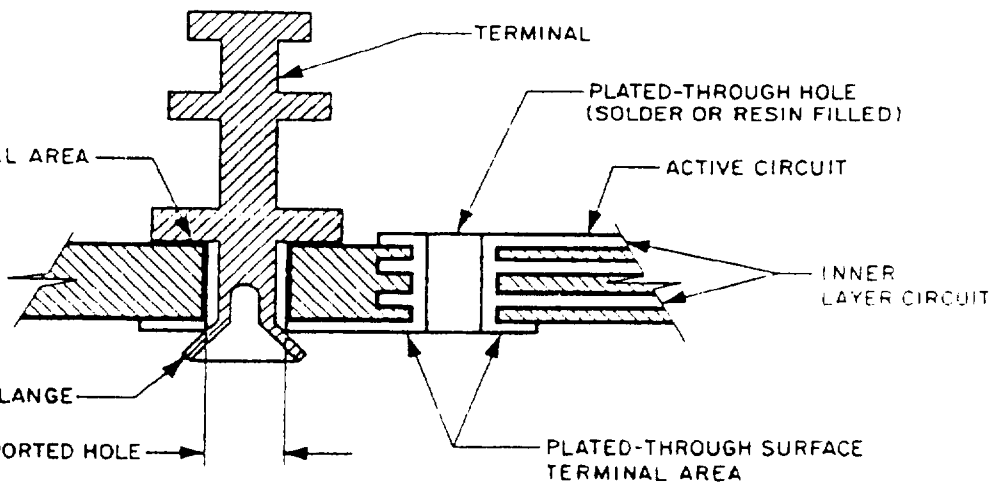


FIGURE 90. Dual hole configuration for interfacial and inter-layer terminal mountings (see 5.3.19.13.6).

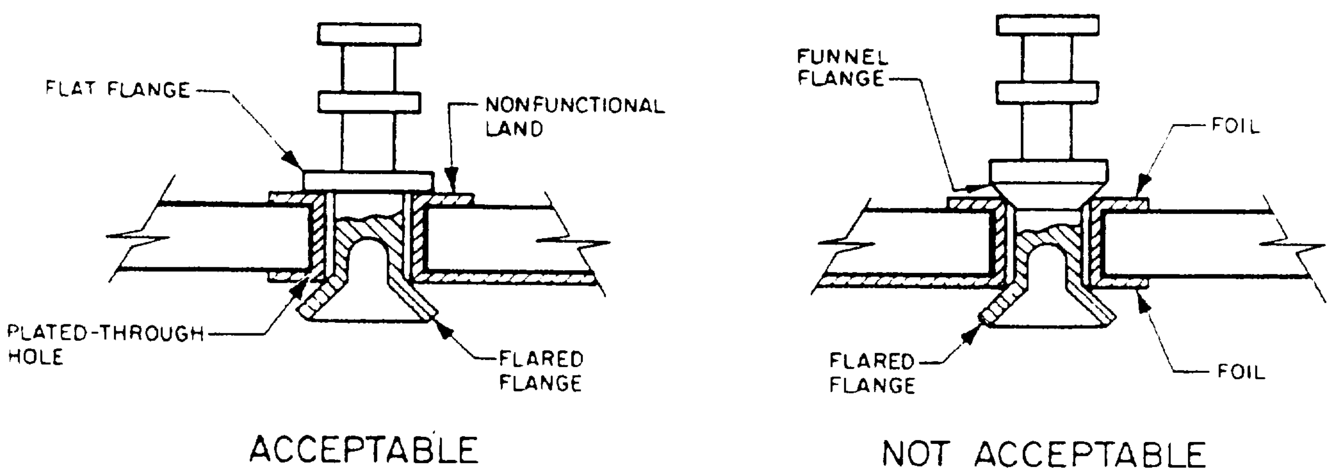


FIGURE 91. Standoff terminal interfacial connection (see 5.3.19.13.6).

5.3.19.13.7 Terminals with a rolled flange on the solder side and a funnel flange on the component side shall not be used (see figure 92).

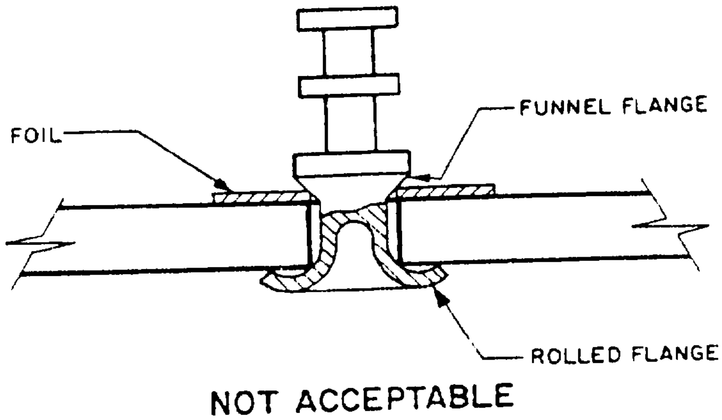


FIGURE 92. Funnel and rolled flange terminal (see 5.3.19.13.7).

5.3.20 Terminal board mountings. Terminals shall be mounted to terminal boards in accordance with 5.3.19.12 and 5.3.19.13.

5.3.21 Mounting to terminals. Whether terminals are mounted to printed boards, terminal boards or chassis members, components and wires shall be mounted in accordance with 5.3.21.1 through 5.3.21.8.

5.3.21.1 Lead wires shall be dressed in the proper position with a slight loop or gradual bend as shown in figure 93. The bend shall be sufficient to preclude tension on the connection when such is finished and to permit one field repair.

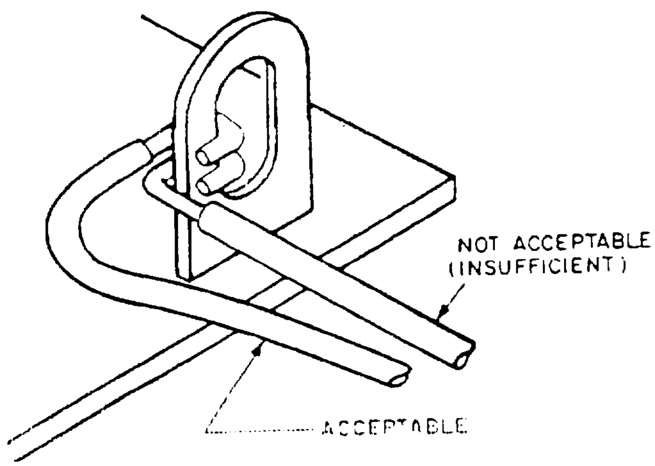


FIGURE 93. Stress relief for lead wiring (see 5.3.21.1).

5.3.21.2 Lead wires may be wrapped clockwise or counterclockwise but shall continue the curvature of the dress of the lead wires (see figure 94) and shall not interfere with the wrapping of other wires on the terminal.

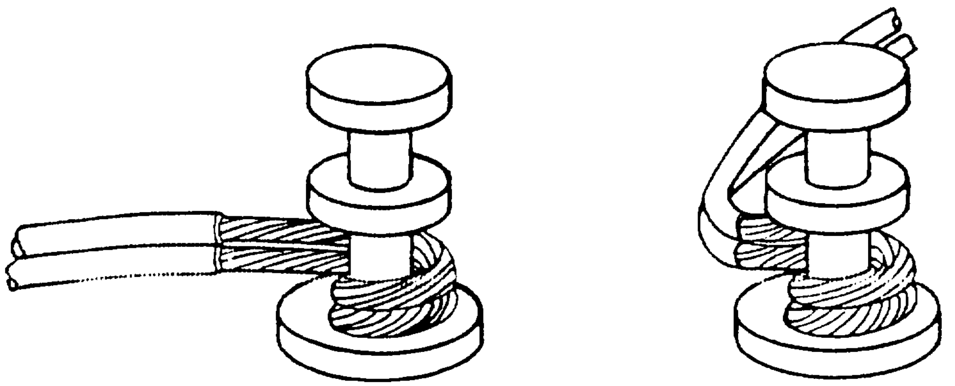
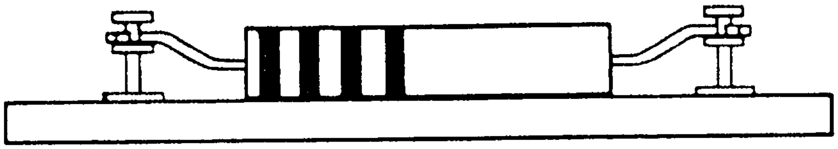


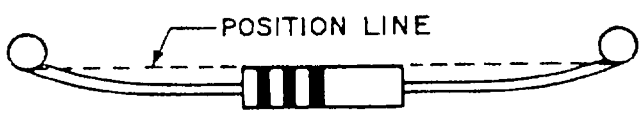
FIGURE 94. Lead dress (see 5.3.21.2).

5.3.21.3 There shall be no more than three attachments to any terminal other than turret or bifurcated terminals and there shall be no more than three attachments to any terminal section of turret and bifurcated terminals.

5.3.21.4 Unless mounted with the component body seated to a printed board, terminal board, or chassis with stress bends as shown in figure 95A, components shall be mounted such that the body is displaced with respect to the terminal to which they are attached as shown in figures 95B, 95C and 95D.



A
VERTICAL PLANE



COMPONENT DIAMETER TO 3/16"
1/2 W RESISTOR (TYP)
B
HORIZONTAL PLANE

COMPONENT DIAMETER
3/16" TO 1/4"
1W RESISTOR (TYP)
C
HORIZONTAL PLANE

COMPONENT DIAMETER 1/4" AND GREATER
2W RESISTOR (TYP)
D
HORIZONTAL PLANE

FIGURE 95. Expansion radii (see 5.3.21.4).

5.3.21.5 Turret terminals.

5.3.21.5.1 Lead wrap. Leads or wires shall be maintained in contact with the post for the full curvature of the wrap which shall extend not less than 180 degrees (1/2 turn) and no more than 270 degrees (3/4 turn) (see figure 96) around the post. There shall be no more than three conductors for each section. The first wire shall be attached to the base and vertical post in the lower section or the shoulder and vertical post in the upper section. Additional wires shall be attached as close as possible to the preceding wire consistent with the insulation thickness. When practicable, except for bus wire, conductors shall be placed in ascending order so that the largest wires are on the bottom. The side route shall be used on all solid post turret type terminals.

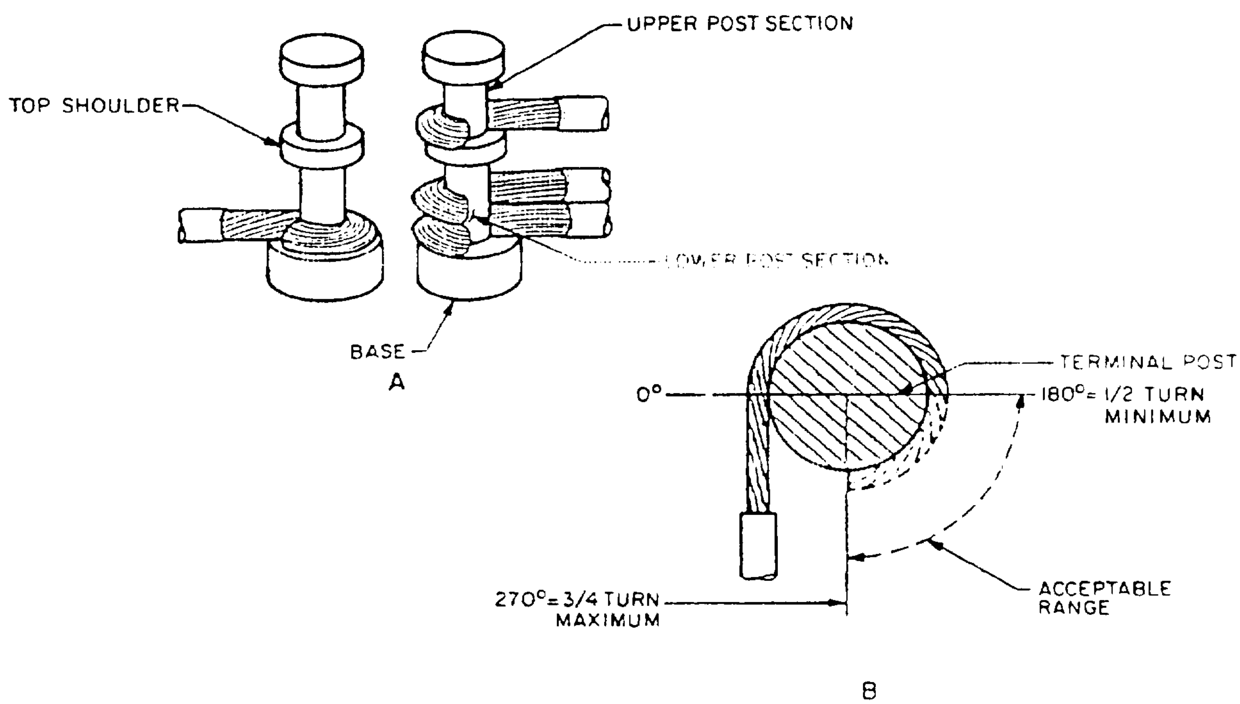


FIGURE 96. Turret terminal wire wrap (see 5.3.21.5.1).

5.3.21.5.2 Continuous run wrapping. If three or more terminals in a row are to be connected, a solid bus wire jumper may be continued from terminal to terminal as shown in figure 97 provided the first and last terminals of the series conform to the 180 to 270 degree requirement.

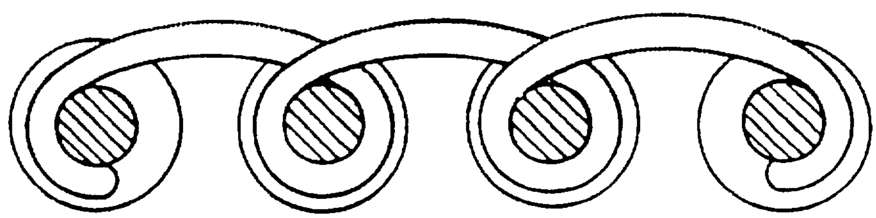


FIGURE 97. Continuous run wrapping, turret terminals (see 5.3.21.5.2).

5.3.21.6 Bifurcated terminals. The order of preferred terminations of bifurcated terminals shall be as follows:

5.3.21.6.1 Side route connection. The wire or component lead shall be dressed through the slot and wrapped to either post of the terminal (see figure 98A). The wire or lead shall be wrapped to the terminal post a minimum of 180 degrees and a maximum of 270 degrees (1/2 to 3/4 turn). The wire or lead shall be wrapped on the terminal post to assure positive contact of the wire with at least two corners of the post (see figure 98D). The wire or lead shall also be in firm contact with the base of the terminal or the previously installed wire (see figure 98B). The number of attachments shall be limited to three per terminal post and shall be maintained such that:

a. There is no overlapping of wraps and wires.

b. Spacing between wires, and spacing between the wires and the terminal board or panel is a minimum consistent with the thickness of the wire insulation.

c. The wraps are dressed in alternate directions (see figure 98C).

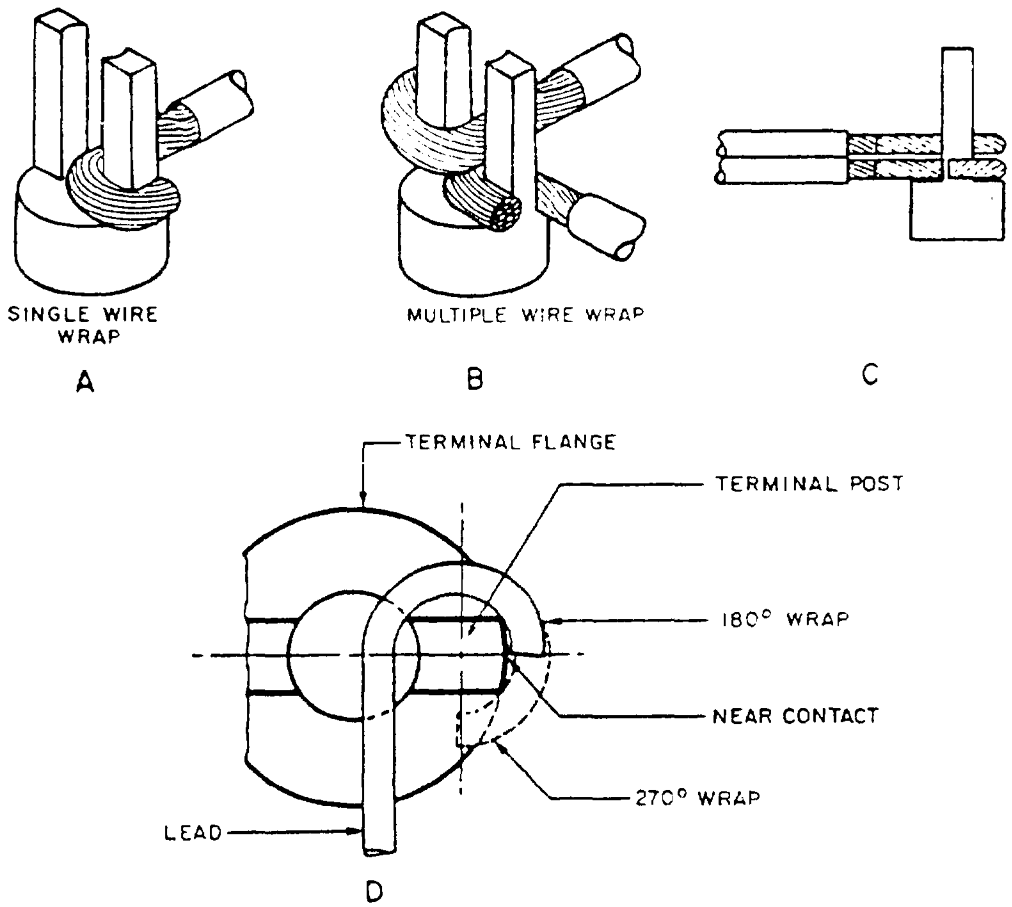


FIGURE 98. Side route connections and wrap on bifurcated terminal (see 5.3.21.6.1).

5.3.21.6.2 Bottom route connection. The wire shall be inserted through the terminal base and wrapped to either post a minimum of 180 degrees and a maximum of 270 degrees (1/2 to 3/4 turn) (see figure 99). The wire shall be wrapped on the terminal post to assure positive contact of the wire with at least two corners of the post. The wire lead shall also be in firm contact with the base of the terminal or the previously installed wire. When more than one wire is to be attached, they shall be inserted at the same time but shall be wrapped separately around alternate posts.

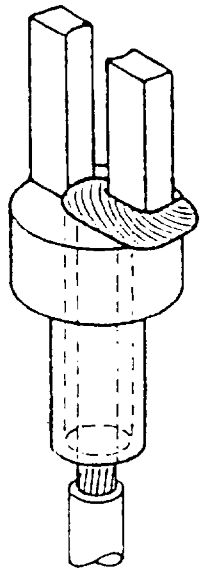


FIGURE 99. Bottom route terminal connection (see 5.3.21.6.2).

5.3.21.6.3 Continuous run connections. When a series of terminals are mounted in a row with the post pairs parallel (see figure 100) and the terminals are to be connected each to the other, such interconnection shall be made in accordance with figures 100, 101, or 102.

5.3.21.6.4 Individual solid jumper wires shall be wrapped between corresponding posts of adjacent terminals in the row (see figure 100). Individual wraps shall be in accordance with 5.3.21.6.1.

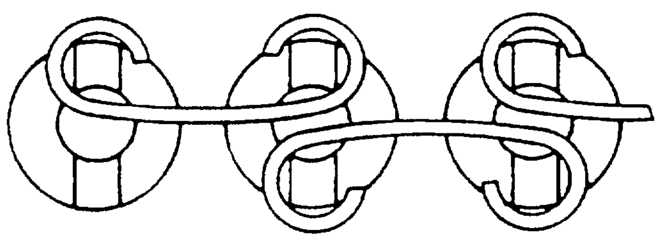


FIGURE 100. Individual wrap, bifurcated terminals (see 5.3.21.6.4).

5.3.21.6.5 A solid jumper wire shall be wrapped to one post of the initial terminal in the row and continued from terminal to terminal with 360 degree wrapping (see figure 101) at the post corresponding with the first until the last terminal is wrapped. The first and last wraps shall be in accordance with 5.3.21.6.1.

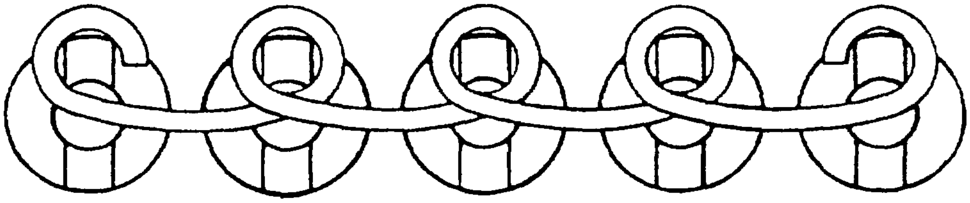


FIGURE 101. Continuous run wrapping, bifurcated terminals (see 5.3.21.6.5).

5.3.21.6.6 A solid jumper wire shall be wrapped to one post of the initial terminal in the row, dressed through the slot of each subsequent terminal without wraps, and wrapped to that post of the last terminal which corresponds with the post of the initial terminal wrapped. The first and last wraps shall be in accordance with 5.3.21.6.1. The unwrapped portion of the jumper shall include a curvature for relief of tension caused by thermal expansion and contraction (see figure 102).

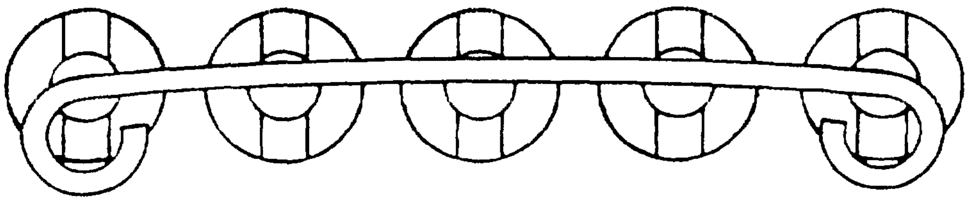


FIGURE 102. Continuous run wrapping, bifurcated terminals, alternate procedure (see 5.3.21.6.6).

5.3.21.7 Hook terminals. The bend to attach wires and leads to hook terminals shall be 180 to 270 degrees (1/2 to 3/4 turn). The maximum wire fill shall not exceed the end of the hooks (see figure 103). There shall be no more than three conductors for each terminal. For size 30 or smaller wire, a maximum terminal wrap of 3 turns may be used. Wires shall be wrapped directly to the terminal and not on prior wrapped wires.

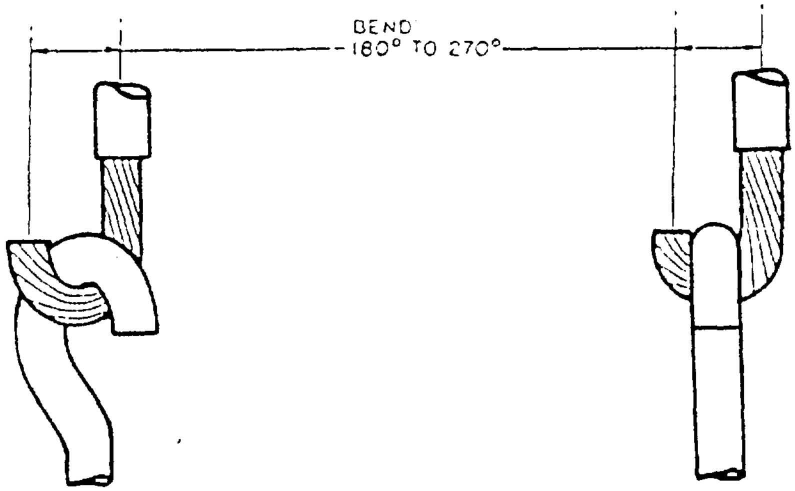


FIGURE 103. Hook terminal connections (see 5.3.21.7).

5.3.21.8 Pierced or perforated terminals. For wiring to a single terminal, the wire shall pass through the eye and be wrapped around the terminal 180 to 270 degrees (1/2 to 3/4 turn), as applicable (see figure 104). If wires are to be attached to a group of terminals such as on transformers, certain relays, and rotary switches, the wires shall be neatly arranged around the terminals in such a manner that they do not cross one another. When a continuous run is more practicable than would be the application of individual jumpers, intermediate terminals of a series to be connected with each other shall be joined with a solid jumper wire threaded through the openings (see figure 104). When a continuous run is used, the wire shall be attached to the end terminals (first and last) in the same manner that wires are attached to single terminals. The jumper wire shall contact at least two nonadjacent contact surfaces of each intermediate terminal.

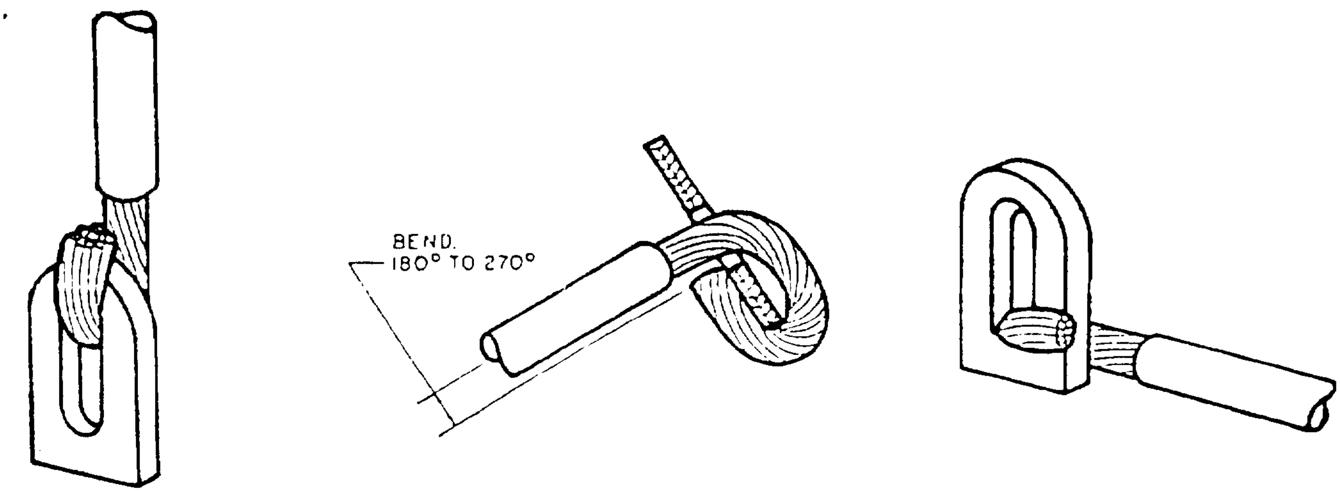


FIGURE 104. Pierced or perforated terminal wire wrap (see 5.3.21.8).

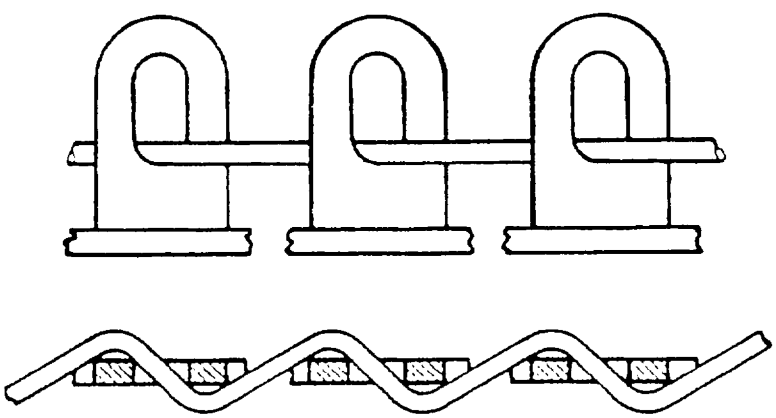


FIGURE 105. Continuous run weaving, pierced or perforated terminals (see 5.3.21.8).

5.4 Task C: General process controls.

5.4.1 Requirements flowdown. The applicable requirements of this standard shall be imposed by each contractor on all applicable subcontracts and purchase orders. The contractor shall not impose or allow any variation from these standards on subcontracts or purchase orders other than those which have been approved by the government for the applicable prime contract.

5.4.2 Specialized technologies. Mounting and soldering requirements for specialized technologies not specified herein shall be considered peculiar and must be identified on the drawing and performed in accordance with documented processes which are subject to review and disapproval.

5.4.3 Visual inspection. One hundred percent visual inspection of all solder connections and assemblies shall be performed in accordance with the requirements specified herein (see 5.4.20.4). Component side connections of components on densely populated printed wiring assemblies shall be inspected to the extent that the component side connections are visible provided that:

a. it is demonstrated to the government that the design does not restrict solder flow to any connection element on the component side of the assembly;

b. the visible portions of the connection (both component and solder side) fully conform to the requirements specified herein; and

c. process controls are maintained in a manner assuring repeatability of assembly techniques.

5.4.4 Solderability.

5.4.4.1 Solderability of leads and terminations. Within 30 days of receipt, external leads, pins and terminals of all components and all terminals to be soldered shall be tested to and conform to the solderability tests specified in MIL-STD-202, Method 208, MIL-STD-750, Method 2026, or MIL-STD-883, Method 2003. Parts received with hot solder dipped coatings which were solderability tested, including steam aging, shall be stored in accordance with 5.4.4.3 Method 2 from the date of testing.

5.4.4.2 Solderability of boards. The solderability of printed wiring boards shall conform to the requirements of MIL-P-55110 for rigid printed wiring and MIL-P-50884 for flexible and rigid-flex printed wiring. Testing may be performed on coupons in lieu of actual boards provided that the coupons were prepared at the same time, from the same lot of materials, and stored under the same conditions as the boards in question. The solderability of printed wiring stored for more than one year shall be reverified in the same manner.

5.4.4.3 Maintaining solderability. The solderability of all components, parts and terminals which have met the requirements of 5.4.4.1 shall be maintained using one of the following methods:

Method 1:

The components, parts or terminals shall be released for production and soldered into an assembly within 120 days of meeting the specified solderability requirements.

Method 2:

a. Leads, pins and terminals of all components and parts, and all terminals shall be tinned with a solder fusing process to provide a minimum of 0.0001 inch thickness. The tinning shall be performed by the contractor, subcontractor or vendor.

b. The components, parts or terminals shall be released for production and soldered into an assembly within 2 years of meeting the specified solderability requirements.

Method 3:

Non-tinned components, parts and terminals which have been held longer than 120 days prior to being soldered into an assembly, shall be retested for solderability and meet the requirements of 5.4.4.1.

Method 4:

a. Components, parts and terminals can be stored for up to 2 years prior to use without additional solderability testing if they meet the solderability test requirements of 5.4.4.1, after being exposed to a minimum of 8 hours of artificial steam aging in accordance with the appropriate component test specification, and if they are stored in accordance with step b. Containers and storage bags must meet the requirements of 5.4.13.

b. The storage environment shall not deviate from the following requirements for a total of more than 90 days in 2 years: Relative humidity 50 percent maximum; temperature 77 degrees F maximum; and gas buildup not to exceed the following limits (given in micrograms per cubic meter of air).

(1)	reducible sulphur	0.2
(2)	sulphur dioxide	10.0
(3)	ammonia	15.0
(4)	chloride (acidic chlorine)	0.1
(5)	dust	20.0

In all cases, components, parts and terminals held in storage for more than 2 years shall, within 120 days of being soldered into an assembly, be retested for solderability and meet the requirements of 5.4.4.1.

5.4.4.4 Component Lead Tinning/Cleaning: Component leads, pins, terminations, terminals and end caps whose solderability per 5.4.4.3 is unsatisfactory shall be:

a. Cleaned using a cleaning process which is controlled to prevent damage or exposing component lead basis metal and sample tested for conformance to the criteria of 5.4.4.1, except steam aging is not required, or

b. Cleaned per 5.4.4.4.a and tinned in accordance with 4.9.3.5 and 4.11.3 and sample tested for conformance to the criteria of 5.4.4.1, except steam aging is not required.

Following procedures (a) or (b), the component leads, pins, terminations, terminals and end caps shall be stored in accordance with 5.4.4.3.

5.4.5 Bow and twist. The bow and twist of the printed wiring assembly circuit board shall not exceed 0.015 inch per inch (0.015 mm per mm). Where the assembly drawing has a tighter requirement, then the drawing requirement shall prevail.

5.4.6 Printed wiring board condition. Before components or terminals are mounted on a printed wiring board, the board shall be examined for conformance to the requirements of 4.5 and 5.4.21. There shall be no evidence of any of the following defects:

a. Scratches which expose basis metal;

b. Separation of the conductor pattern (including terminal areas) from the base laminate;

c. Blisters in the conductor pattern;

d. Measling or crazing which may result in an unacceptable finished product or which exceeds the requirements of 5.4.21.9, except that the sum of the measled areas of any printed wiring board shall not exceed 1.5 percent of the surface area of one of its sides (see 5.4.21.9.b);

e. Delamination of the base material;

f. Wrinkles in the conductor pattern;

g. Dirt, grease, or other foreign matter on the printed wiring boards; and

h. Pits or inclusions.

5.4.7 Selection of surface mounted components.

5.4.7.1 Barrier coatings. Components with sintered-metal-on-ceramic terminations shall have a a diffusion barrier coating of electrolytically-deposited nickel conforming to QQ-N-290, Class 2 incorporated between the sintered precious metal (see MIL-G-45204) and the finish coating.

5.4.7.2 Reflow configuration parts. There shall be no discontinuities in the metallized terminal areas of leadless components of the reflow configuration (see figure 51).

5.4.7.3 End cap configuration parts. Discontinuities in the metallized and caps shall not reduce the effective width (W) by more than 20 percent nor the area by more than 30 percent (see figure 106).

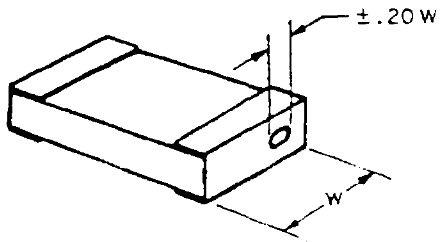


FIGURE 106. End cap discontinuities (see 5.4.7.3).

5.4.8 Harness and cable assemblies. Harnesses and cable assemblies shall conform to the requirements of MIL-C-45224 or an equivalent specification approved by the procuring activity except that soldering processes and acceptance criteria shall be as stated herein. Wax-impregnated lacing tape shall be utilized only for harnesses which will not be subjected to cleaning solvents subsequent to lacing operations. Tape impregnated with bee's wax shall not be used.

5.4.9 Facilities.

5.4.9.1 Environmental controls. An enclosed soldering facility, maintained at a slight positive pressure, shall be required if the soldering area is not air conditioned.

5.4.9.2 Temperature and humidity. The temperature shall be maintained at 75 + 9°F (24 + 5°C) and the relative humidity shall not exceed 65 percent. When humidity decreases to a level of 30 percent or lower, electrostatic discharge sensitive devices and assemblies shall be processed using extraordinary controls for the protection of electrostatic sensitive devices and assemblies in accordance with MIL-STD-1686.

5.4.9.3 Vapors control. Areas used for cleaning parts and areas where toxic or volatile vapors are generated shall include a local exhaust system utilized for removing air contaminants from the area in which they are generated. As a minimum, the exhaust unit utilized shall be in accordance with the recommendations or guidelines of the Industrial Ventilation Manual of Recommended Practices and applicable CFR, Title 29, Part 1900 to 1919, Chapter XVII Occupational Safety and Health Administration (OSHA) requirements.

5.4.10 Magnification aids and lighting. The tolerance for magnification aids is 15 percent of the selected magnification power (i.e. + 15% or a range of 30 percent centered at the selected magnification power). Magnification aids and lighting used for inspection shall be commensurate with the size of the item being processed and conform to the following:

a. Magnification aids of 2X to 4X for use during the inspection of other than solder connections.

b. Magnification aids for inspection of solder connections shall be 4X to 10X. For inspection of solder connections, magnifications aids of a type that permit simultaneous viewing with both eyes are preferred. Single-eyed viewing devices, however, are acceptable.

c. Light sources shall provide illumination of the solder connection being inspected from at least two directions at least 80 degrees apart so that no shadows fall on the connection except those caused by the connection itself or the leads entering the connection. Light sources used for inspection shall be selected such that defects including exposed copper can be detected.

d. Optical systems utilized shall provide a field of view suitable to permit inspection of each solder connection but shall in no case be less than plus or minus 10 degrees apparent field-of-view angle measured from the center of the field as seen by the viewer.

NOTE: Additional guidance for magnification aid selection is provided in Appendix D.

5.4.11 Heat sources for use with heat-shrinkable solder devices. Hot air convection heating tools used for installing heat-shrinkable solder devices shall produce a stream of heated air of sufficient volume and temperature for the application. Suitable air reflectors shall be used to concentrate and control the heated air around the product being installed and to prevent damage to adjacent components, insulations, or boards. Other types of heat sources such as infra-red, conduction, induction, etc. shall be utilized in accordance with a documented process which is subject to review and disapproval.

5.4.12 Antiwicking tools. Antiwicking tools shall be of a design which fits only a specific conductor gage size and shall be marked with that conductor gage size.

5.4.13 Storage Containers. Containers or bags which are utilized to store printed wiring boards, solderable components, or solderable wire shall be of a material that does not introduce gases or chemicals which are detrimental to the item or its solderability. In the case of tape and reel components, the tape and reel materials shall not detrimentally affect the solderability of the surfaces to be subsequently soldered. Bags, containers and tape and reel materials used for storage of electrostatic sensitive devices shall provide device protection in accordance with DOD-STD-1686.

NOTE: Containers, bags, tape and reel materials, or combinations may be verified under accelerated aging test conditions to determine whether item solderability is detrimentally affected. Silicones, sulphur compounds, polysulphides, etc., have been found to be detrimental to component solderability.

5.4.14 Soldering equipment. Soldering irons, soldering machines and systems, and associated process equipment (including fluxers, preheaters, solder pots, cleaning system, and cleanliness test equipment) shall be of a type that does not compromise functional integrity by injecting electrical energy to the item(s) being soldered or being cleaned. For soldering irons, resistance between items processed and ground shall be no greater than 2.0 ohms measured from the tip of the hot soldering irons. Soldering, cleaning and processing equipment shall be in accordance with DOD-STD-1686 for electrostatic discharge protection. Potential differences between ground and the tip of the hot soldering irons shall be no greater than 2 millivolts RMS measured as detailed in Appendix B or equivalent method.

5.4.14.1 Soldering irons. Soldering irons shall be of the temperature controlled type, controllable within ±10°F (±5.5°C) of the preselected idling temperature unless it can be demonstrated to the procuring activity that uncontrollable irons are essential for a particular application. The size and shape of the soldering iron and tip shall permit soldering with maximum ease and control without causing damage to adjacent areas or connections. The soldering iron or resistance heating element shall heat the connection area rapidly and maintain proper soldering temperature at the connection throughout the soldering operation. Three-wire cords and tip grounding to prevent potential greater than two millivolts RMS at the tip shall be used when soldering. The soldering iron shall be of such design as to provide zero voltage switching. Transformer type soldering guns shall not be used.

5.4.14.2 Soldering iron tips. The soldering iron tips or resistance soldering element shall be sized to the operations involved. Soldering iron tips shall be made of commercially pure copper, tellurium copper, or lead copper and shall be plated or coated with another metal that prevents degradation of the tip in molten solder.

5.4.15 Mass solder application systems.

5.4.15.1 Wave soldering machines. In addition to 4.9.3.6 and 4.9.3.7, wave soldering machines shall have the capacity to preheat the assembly to within 120°C (216°F) of the solder temperature immediately prior to contact with the molten solder.

5.4.15.2 Other soldering systems. Drag soldering and other soldering equipment not specified herein shall be utilized in accordance with a documented process which is subject to review and disapproval.

5.4.15.3 Soldering equipment for reflow soldering of pianar mounted components. The soldering device and machine used shall be of such design to rapidly heat the surfaces to be joined and shall have the capacity to re-attain the preset temperature within ±10°F (±5.5°C) during repetitive soldering operations. The heat source shall not cause damage to the board or components or contaminate the solder when direct contact is made between the heat source and the metals to be joined. Reflow soldering equipment (including equipment which utilizes parallel gap resistance, shorted bar resistance, hot air, infrared, laser powered devices, or thermal transfer soldering techniques other than soldering irons) shall be utilized in accordance with a documented processes which is subject to review and disapproval.

5.4.15.4 Condensation reflow system. The condensation reflow system shall be mechanized to provide for smooth transition of the work piece and of such design to prevent electrostatic discharge damage to components. The nonflammable, inert, chemically, and thermally stable liquid used to produce the vapors shall be maintained to produce consistent high quality metallurgical bonds. The level of vapor in the equipment shall be controlled so that the dwell time of the work piece is minimal while insuring that the solder and work piece have reached a temperature sufficient to produce the metallurgical bonds. Condensation reflow systems shall be utilized in accordance with documented processes which is subject to review and disapproval

5.4.16 Solder purity. In addition to 4.10.1, when procured, type BS solder shall contain no more than 0.01 percent phosphorus and no more than 0.001 percent sulphur.

5.4.17 Preparation for soldering.

5.4.17.1 Insulation removal. Insulation shall be removed from wire conductors by one of the following methods, using the tools specified in 4.11.2. After insulation removal, insulation deformation shall not exceed 20 percent of the insulation thickness. The insulation shall not have gouges, ragged edges nor be loose or frayed. Slight discoloration of the insulation from thermal stripping is acceptable. At no time during the soldering process shall insulation that is degraded from the use of solvents or chemical stripping agents be acceptable. Wires or strands shall not be broken, birdcaged, severed, nor show evidence of nicks, cuts, scrapes, stretching, or other observable damage exceeding 5 percent of the wire diameter when viewed under 4X magnification. Discoloration of the wires or strands that shows evidence of overheating shall be cause for rejection.

5.4.17.1.1 Thermal. When extruded insulation is removed using a thermal stripping tool, the lay of the wire shall be restored, if disturbed, without using bare finger contact. Thermal type insulation strippers are preferred for wires of size 20 AWG and smaller.

5.4.17.1.2 Mechanical. When extruded insulation is removed using a mechanical stripping tool, the lay of the wire strands shall be restored, if disturbed, without using bare finger contact. A device that utilizes fiberglass stripping wheels may be used for magnet wire.

5.4.17.1.3 Chemical. Insulation removal from magnet wire shall be accomplished by the use of chemical stripping agents, in accordance with the manufacturer's recommendation. Chemical stripping agents shall be neutralized or removed prior to soldering.

5.4.17.1.4 Solder dip. Polyurethane or similar type coatings may be removed by dipping the insulated wire to the required depth into a solder pot (see 4.9.3.5) at the temperature recommended by the manufacturer. Stripping of solder strippable magnet wire (with polyurethane or similar insulation) on the termination of coils and windings wound with such wire may be performed by hot solder application in compliance with the wire manufacturers recommendations.

5.4.17.2 Preparation of gold plated areas. Areas of connectors and component leads to be soldered which have more than 0.000100 inches (0.00254 mm) of gold plating shall be prepared for soldering by implementation of either of the two (2) following methods:

Method 1. Static bath. Immerse the fluxed gold plated lead in solder bath number one for 2 to 5 seconds. Only the portion of the lead subsequently to be soldered need be immersed. Gold contamination level in solder bath number one shall be less than 4 percent. Immerse the fluxed tinned lead in solder bath number two for 2 to 5 seconds. Gold contamination in bath number two shall not exceed the limits specified in table V.

Method 2. Dynamic bath. Immerse the fluxed gold plated lead in a flowing solder bath for 2 to 5 seconds. Only the portion of the lead to be subsequently soldered need be immersed. Gold contamination in the solder bath shall not exceed the limits of column 1 (Preconditioning) of table V.

5.4.17.2.1 Cup type connections. The inside portion of cup type connections shall be tinned in accordance with a or b below:

a. Steps 1 through 6 below shall be performed if solder cups are not gold plated or are gold plated to a thickness between 0.000050 and 0.000100 inches (0.00127 and 0.00254 mm).

b. Solder cups gold plated in excess of 0.000100 inches (0.00254 mm) shall be tinned in accordance with steps 1 through 7 below.

Step 1: Clean solder cups using a solvent or cleaner specified in 4.10.4.

Step 2: Place sufficient solder in the solder cup to completely fill the solder cup, to the milled lip, after melting.

Step 3: Heat solder cup sufficiently to melt solder and allow all gases and flux to escape (cups should be at approximately a 45 degree angle to prevent entrapment of gases and flux).

Step 4: Remove solder by wicking or extraction device.

Step 5: Inspect inside of cup to ensure complete tinning of solder cup.

Step 6: Place sufficient solder in the solder cup to allow proper fillet after wires are inserted into the cup.

Step 7: Repeat steps 3 through 6 one time.

5.4.17.2.2 Post gold removal processing. Upon conclusion of the gold removal process, the solder coated portion of the component shall conform to the acceptance criteria of 5.4.4.1 and be maintained in accordance with 5.4.4.3.

5.4.17.3 Lead bends. The distance between the body of the component or weld and the bent section of a lead shall be in accordance with 4.11.4 thru 4.11.4.4 or, if applied, the mounting criteria specified in Task B.

5.4.17.4 Stress relief. Components with wires or leads terminated at a solder connection shall be mounted to assure stress relief of the component in accordance with 4.11.4 thru 4.11.4.4 or, if applied, the mounting criteria specified in Task B. The leads of components mounted horizontally with bodies in direct contact with the printed wiring assembly shall be formed to assure that excess solder is not present in the formed bends of the component leads (see 5.4.21.17).

5.4.17.5 Lead trimming. Wires and leads shall be cut to their proper length prior to soldering. When leads are cut after insertion in the printed wiring board, the cutting action shall not damage the printed wiring board or components mounted thereon. When automatic lead cutting is performed, a maintenance program shall be implemented to provide assurance that blades or saws are monitored for wear, and that the feed system is calibrated to match the needs of the materials and density of leads being cut. Cutting shall not bend the lead nor leave sharp spurs on lead ends.

5.4.17.6 Tinning of stranded wire. Stranded wire portions which come in contact with the area to be soldered shall be tinned with molten solder prior to attachments. Damage to the insulation due to wicking shall not be acceptable. The solder shall penetrate to the inner strands of the wire and shall exhibit acceptable wetting over the entire tinned portion of the wire. The contour of the individual strands shall remain visible in the tinned portion of the wire.

5.4.17.7 Precleaning. Items shall be clean prior to soldering or bonding. The solvents of 4.10.4 shall be used for cleaning.

5.4.18 Handling and storage of parts. Leads and to-be-soldered surfaces of component wires and printed wiring boards shall not be handled with bare hands. If the parts cannot be handled without touching the surface to be soldered, protective devices such as clean nylon or cotton gloves, finger cots, or special tooling shall be used.

CAUTION: Finger cots and nylon gloves should not degrade electrostatic discharge protection as defined in DOD-STD-1686.

NOTE: Printed wiring boards should be oven dried prior to being used in any soldering process to prevent defects such as measles, crazing and delaminations.

5.4.19 Post soldering operations.

5.4.19.1 Cleaning. Connections to terminals, printed wiring assemblies, terminal board assemblies, soldered chassis elements, and electrical/electronic modules shall be cleaned using a solvent, cleaner or combination of solvents (see 4.10.4) within a time frame that affords total removal of contaminants and flux residue. The time between solidification of the solder and assembly cleaning shall not exceed 30 minutes except for the hand soldered connections of operations requiring the adding of additional components during production, rework, or repair with interim cleaning (at the work station) being accomplished. When interim cleaning is used, some flux residues may remain longer than 30 minutes, provided the contractor has demonstrated that the final cleaning process used results in removal of all flux and contaminants from the finished product, and removal of flux residues is accomplished prior to the end of the production shift using a system as defined below. Printed wiring assemblies, terminal board assemblies to which electrical components are added, and electrical/electronic modules shall be cleaned in a manner that will prevent both thermal shock to the assemblies, modules, or components thereon or therein and moisture intrusion into components not totally sealed. The cleaning of printed wiring assemblies, terminal board assemblies to which electrical components are added, and electrical/electronic modules shall be accomplished with a cleaning system in accordance with 5.4.19.1.1, 5.4.19.1.2, 5.4.19.1.3, or 5.4.19.1.4 or combination thereof except for interim cleaning as previously defined.

5.4.19.1.1 Dip tanks. Printed wiring assemblies, terminal board assemblies, soldered chassis elements, and electrical/electronic modules shall be subjected to three separate cleaning baths each of which contain a solvent or blend of solvents (see 4.10.4) identical to that in the other two. Immersion time in each tank shall not exceed 60 seconds. The assembly, after cleaning, shall be capable of meeting the requirements of 4.18 or 5.4.19.7. Tank 3 shall be the final solvent of the cleaning process and the contamination content shall not exceed the value calculated and posted at the cleaning station. The solvents in the tanks shall be changed as follows: the solvent in tank 1 shall be discarded; the solvent in tank 2 may be placed in tank 1; the solvent in tank 3 may be placed in tank 2 and fresh solvent shall be placed in tank 3.

a. Use of a clean brush is permissible.

b. The printed wiring assembly shall be air dried after cleaning, using ambient air or compressed air which is oil-free and has a moisture content less than 2500 ppm measured at room ambient temperature. Air pressure up to 40 pounds per square inch gauge (psig) (276 kPa) may be used, provided it does not damage the assembly.

5.4.19.1.2 Vapor degreasing. Use of vapor degreasing for cleaning printed wiring assemblies, terminal board assemblies, soldered chassis elements, and electrical/electronic modules is permissible provided that solvents are in accordance with 4.10.4 and compatible with the particular vapor degreaser utilized. The assembly, after cleaning, shall be capable of meeting the requirements of 4.18 or 5.4.19.7. The contamination of the solvent in the boiling sump of the degreaser shall not exceed the value calculated and posted at the cleaning station.

5.4.19.1.3 Detergent cleaning. The use of a detergent or saponifying cleaning system is permissible for cleaning printed wiring assemblies, terminal board assemblies, soldered chassis elements, and electrical/ electronic modules provided that solvents are in accordance with 4.10.4. The assembly, after cleaning, shall be capable of meeting the requirements of 4.18 or 5.4.19.7. The contamination of the cleaner solution in the system shall be calculated in percent by weight and shall not exceed the posted value.

5.4.19.1.4 Ultrasonic cleaning. The use of ultrasonic cleaning devices on components, printed wiring assemblies, terminal board assemblies, soldered chassis elements, and electrical/electronic modules is prohibited except for assemblies containing only terminals or connectors without internal electronics. Ultrasonic cleaning may be used on bare printed wiring boards. The assembly, after cleaning, shall be capable of meeting the requirements of 4.18 or 5.4.19.7. The contamination of the solvent in the system shall not exceed the value calculated and posted at the cleaning station.

5.4.19.2 Initial inspection. After soldering and cleaning, each item shall be inspected in accordance with 5.4.20.

5.4.19.3 Rework of unsatisfactory solder connections. Rework operations shall be performed only by appropriately trained and certified personnel. Rework of unsatisfactory solder connections shall not be performed until discrepancies have been documented. This data shall be used to provide an indication as to possible causes and to determine if corrective actions are required in accordance with 5.4.20.4. Personnel shall not inspect their own work.

5.4.19.3.1 Methods for rework by hand soldering.

5.4.19.3.1.1 Reheat method of rework. When rework is required, it may be accomplished by adding flux and solder, if necessary, for the following types of defects:

a. Nonsoldered connections.

b. Cold solder connections.

c. Fractured or disturbed connections.

d. Insufficient solder.

e. Poor wetting.

f. Pits, holes, or voids in connection.

g. Visible basis metal in solder connection.

h. Solder points, peaks, or icicles.

5.4.19.3.1.2 Resolder method of rework. When rework is required, defective solder connections and other defects which cannot be corrected in accordance with 5.4.19.3.1.1 shall be reworked by first removing the solder by a vacuum device or wicking and then cleaning and resoldering the connection.

CAUTION: Extreme care should be exercised when wicking solder out of plated-through hole.

5.4.19.3.2 Machine resolder method of rework. Assemblies which are initially soldered by machine soldering and which contain defective solder connections, may be resoldered/reworked in accordance with 5.4.19.3.1 or by passing them through the same machine soldering process, with process control corrections, a single time to reflow all connections.

5.4.19.4 Post rework cleaning. After rework, printed wiring assemblies shall be cleaned in accordance with 5.4.19.1 and tested in accordance with 4.18.

5.4.19.5 Handling and storage after cleaning. After final cleaning, and prior to application of conformal coating or encapsulation, unfinished printed wiring assemblies shall not be handled in a manner such that areas to be conformally coated or encapsulated come in contact with bare hands or visibly contaminated tools. Such assemblies shall be stored and processed in a controlled environment (see paragraph 5.4.9.1).

5.4.19.6 Visual inspection of reworked defects. Each reworked defect including each resoldered or reheated connection shall be reinspected in accordance with 5.4.20 and 5.4.20.4 and shall conform to the acceptance criteria of 4.19 and 5.4.21. Assemblies which have been reworked in accordance with 5.4.19.3 thru 5.4.19.3.2 shall be completely reinspected for defects in accordance with 5.4.20.4.

5.4.19.7 Cleanliness testing prior to conformal coating or encapsulation. Printed wiring assemblies, terminal board assemblies, soldered chassis elements, and electrical/electronic modules shall be tested for ionic contamination in accordance with 4.18 using MIL-STD-105 immediately prior to conformal coating or encapsulation. If any assembly fails the entire lot shall be recleaned and retested.

5.4.19.8 Conformal coating process. To facilitate the removal of defective components, the printed wiring assembly should be functionally tested prior to the conformal coating or any encapsulation process.

5.4.19.9 Conformal coating. Conformal coating requirements for printed wiring assemblies shall be specified on the assembly drawing. When used, conformal coating shall conform to MIL-I-46058 and 5.4.19.9.1 through 5.4.19.9.8, below. The coating shall be applied to both sides of the printed wiring assemblies using either a brush, dip, spray or vacuum deposition system which is suitable to the particular assembly. Edge coating is optional unless otherwise specified on the assembly drawing.

5.4.19.9.1 Conformal coating application. Conformal coating material shall be as specified on the Government approved assembly drawing. The material specification and manufacturer's instructions, as applicable, shall be followed and the material shall be used within the time period specified (both shelf-life and pot life). The coating shall be a minimum thickness (see 5.4.19.9.5) and fillets shall be kept to a minimum consistent with the size, weight, and mounting provisions of the components. A continuous coating shall be applied to both sides of the printed wiring assembly, using either a brush, dip, spray or vacuum deposition method which is suitable to the particular assembly and within the following criteria (see paragraphs 5.4.19.9.2 through 5.4.19.9.8). The coating shall be applied without bubbles, blisters, or breaks which might affect the printed wiring assembly operations, or sealing properties of the conformal coating.

5.4.19.9.2 Conformal coating on adjustable components. Assemblies having adjustable components shall not have the adjustable portion covered with the coating. Shafts of adjustable components shall be adjusted and sealed in accordance with 5.4.19.10.2.

5.4.19.9.3 Conformal coating on connectors. Mating connector surfaces of printed wiring assemblies shall not be coated with the conformal coating. The conformal coating or additional material specified on the assembly drawing shall, however, provide a seal between the connector and board and around all mounting devices of the connector.

5.4.19.9.4 Conformal coating on brackets. Printed wiring assemblies having brackets or other mounting devices shall not have the mating surfaces of said devices coated with conformal coating unless required on the assembly drawing. However, the junction between these devices and the board and all attaching hardware shall be coated with conformal coating or additional sealant material specified on the assembly drawing to provide a seal between the mounting device and the board.

5.4.19.9.5 Conformal coating thickness. The coating thickness for the type of conformal coating used shall be in accordance with MIL-I-46058 or as specified on the assembly drawing. The thickness shall be measured on a flat, unencumbered, cured surface of the printed wiring assembly or a coupon which has been processed with the assembly. Coupons may be of the same type material as the printed wiring board or may be of a nonporous material such as metal or glass.

5.4.19.9.6 Conformal coating on flexible leads. Components which are electrically connected to the printed wiring assembly by flexible leads shall have, as a minimum, the junction of the leads with the components and the printed wiring assembly coated.

5.4.19.9.7 Perimeter coating. Unless otherwise specified on the government approved assembly drawing, the outer perimeter of printed wiring assemblies shall not be increased in total thickness, by more than .040 inch (1.02 mm) as a result of conformal coating. The "outer perimeter" is defined as the area on each side of the board a distance of not more than 1/4 inch (6.35 mm) inward from the outer edge.

5.4.19.9.8 Edge coating. Unless otherwise specified on the government approved assembly drawing, the dimensions of the printed wiring assemblies shall not be increased in length or width by more than 0.030 inch (0.762 mm) on each edge, total 0.060 inch (1.524 mm), by application of conformal coating.

5.4.19.10 Adjustable components.

5.4.19.10.1 Adjustment. Adjustable components which incorporate integral adjustment locking mechanisms may be adjusted and locked prior to conformal coating. All other adjustable components shall be adjusted and staked after the assembly has been conformally coated.

5.4.19.10.2 Staking of adjustable components. After post-encapsulation adjustment, the external shafts of adjustable components which do not incorporate integral locking mechanisms shall be mechanically staked or sealed with pthalic alkyd resin enamel in accordance with MIL-E-22118. The sealant shall be used unthinned and only enough material to make the seal should be used.

5.4.19.11 Rework of conformal coating. Procedures which describe the removal and replacement of conformal coating or encapsulation shall be documented and available for review.

5.4.20 Inspection. The contractor shall be responsible for conformance to the product and process requirements specified in this standard and shall also perform all process and product inspections and tests required by this standard either directly or by subcontract. The contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein unless such other facilities are disapproved by the Government. The Government reserves the right to perform an audit or survey addressed to any requirements set forth herein when such an audit is deemed necessary to assure that the supplies and services conform to the prescribed requirements. The contractor shall prepare and maintain process control procedures for all processes, inspections and tests required in the series of standards. These procedures shall provide sufficient detail to allow accomplishment by personnel of the appropriate skill level. They shall also delineate the accept/reject criteria and any special inspection requirements.

5.4.20.1 Surveillance. A surveillance program shall be conducted to determine that compliance with the requirements herein are being maintained and to observe the control and disposition of nonconforming material. This includes periodic inspection of the work area, tools, materials, procedures and processes.

5.4.20.2 Inspection of tools and equipment. Tools and equipment shall be inspected for conformance to the applicable requirements contained herein. In addition, heat sources, soldering irons, solder pots, and process equipment shall be tested in accordance with 5.4.20.2.1, 5.4.20.2.2, 5.4.20.2.3 and 5.4.20.2.4, respectively. Users should check hand tools daily for proper operation and cleanliness.

5.4.20.2.1 Heat sources tests. Heat sources shall be checked by the operator daily to ensure proper operation, heat range, and overall maintenance. The heat range may be checked by performance in lieu of taking actual temperature measurements. Nozzles, air deflectors and adapters, input power cords, and plugs on cords shall be examined and there shall be no condition that could cause damage to items to be processed.

5.4.20.2.2 Soldering irons. Soldering irons shall be tested subsequent to receipt after purchase and prior to issue for soldering operations and shall meet physical and functional characteristics in accordance with 5.4.14 and 5.4.14.1. Soldering irons in use shall be tested at periodic intervals as defined in 5.4.20.2.2.2 and 5.4.20.2.2.3. When not retained in stores, each soldering iron shall be examined in accordance with 5.4.20.2.2.1 prior to use during any day the iron is in use. If repaired or modified, soldering irons shall be retested and shall conform to all requirements of 5.4.14 and 5.4.14.1 before the iron is utilized for production use.

5.4.20.2.2.1 Daily check by operator. The following shall be performed daily by the operator. Before the iron is energized, the handles, input power cord, power cord plug, and other elements shall be examined for physical damage. There shall be no conditions that could result in defective connections and in damage to components and other items to be soldered. Tips and heating elements shall be examined and there shall be no oxidation, corrosion, or foreign materials that restricts or impedes mating between tip and heating element or heating element and iron. Irons and tips shall be examined for compatibility with the soldering operations to be performed. The size and shape shall be in accordance with 5.4.14.1. Operators shall ensure the proper operation and performance of heated irons.

5.4.20.2.2.2 Quarter-year tests. The following tests shall be performed quarterly. The intervals shall be shortened as required to assure continued conformance with the specified requirements as evidenced by the results of preceding periodic measurement tests and may be lengthened only when the results of such prior periodic tests provide definite indication that such action will not result in use of out-of-conformance irons. Tip-to-ground resistance shall be measured and shall conform to 5.4.14 and 5.4.14.1. The tip temperature of non-adjustable temperature-controlled irons shall be measured and shall be within ±10°F (±5.5°C) of the rated (idling) temperature (see 5.4.14.1). The tip temperature of adjustable temperature-controlled irons shall be measured, as a minimum, at three separate pre-selected tip temperatures with one each at a low, middle, and high temperature in the adjustable range of the iron. The tip temperature shall be within ±10°F (±5.5°C) at each of the three preselected temperatures.

5.4.20.2.2.3 Semi-annual tests. The following tests shall be performed semi-annually. The intervals shall be shortened as required to assure continued conformance with the specified requirements as evidenced by the results of preceding periodic measurement tests and may be lengthened only when the results of such prior periodic tests provide definite indication that such action will not result in use of out-of-conformance irons. Soldering irons shall be tested for potential differences between tip and ground and the difference shall be no greater than as specified in 5.4.14.1 when measured as specified in 5.4.14.

5.4.20.2.3 Solder pot tests. Stand-alone solder pots and solder pots integral to machine soldering systems shall be tested subsequent to purchase and receipt of the pot or machine and prior to initial use in soldering operations (including tinning and solderability testing). The pots shall conform to 5.4.14 and 5.4.14.4 when tested. Stand-alone solder pots and those integral to machine soldering systems shall be tested at 6-month intervals for pot solder-to-ground resistance (see 5.4.14), for solder temperature (see 5.4.14.4), and for electrical potential difference between pot solder and ground (see 5.4.14). The 6-month intervals shall be shortened as required to assure continued conformance with specified requirements as evidenced by the results of preceding periodic tests and may be lengthened only when the results of such previous periodic tests provide a definite indication that such action will not result in use of out-of-conformance pots. Solder pots shall also be examined daily for overall maintenance. The input power cord, the input power plug, connections to terminal lugs (if any), and other physical attributes of the pot shall be examined. There shall be no condition that could result in damage to work in process.

5.4.20.2.4 Process equipment. Process equipment shall be tested subsequent to purchase and receipt and prior to initial production use and shall conform to requirements of 5.4.14. Except for tests of integral solder pots, process equipment shall be tested annually to assure that resistance between any item to be processed and ground is no greater than specified, that electrostatic discharge protection is as specified in 5.4.14, and that potential difference between items to be processed and ground is no greater than specified in 5.4.14. The interval between tests shall be shortened from annual to a shorter span as required to assure continued conformance with specified requirements as evidenced by the results of preceding periodic tests and may be lengthened only when the results of such preceding periodic tests provide a definite indication that such lengthening will not result in use of out-of-conformance process equipment.

5.4.20.3 Inspection of material. All materials listed in 4.10 shall be inspected for compliance with the requirements of 4.10.1 through 4.10.4.4. Material controls shall be implemented to ensure that only conforming materials, tools and equipment are used. Materials, tools and equipment not conforming or not required for the operations involved shall be removed from the work area.

5.4.20.3.1 Inspection of printed wiring boards. Printed wiring board shall be inspected and tested for conformance to 4.5 as modified by 5.4.5 and 5.4.6. Sampling inspection shall be as delineated in MIL-P-55110 or MIL-P-50884, respectively.

5.4.20.3.2 Inspection records. Accurate records shall be kept which provide evidence that the materials and tools are either listed on a Qualified Parts List (QPL) or that sufficient testing has been performed to satisfy the requirements of the applicable material specification and any additional requirements specified herein.

5.4.20.4 Inspection of soldered connections and assemblies. Assemblies which include soldered connections shall be inspected to assure conformance in accordance with 5.4.3 The contractor shall implement a system of process control to monitor the soldering process(es) and determine defect/process indicator rates using 100% inspection prior to any touchup and/or rework. Statistical sampling may be used in lieu of 100% inspection when done as part of a process control system approved by the procuring activity. Effective monitoring and control of the process(es) shall be maintained using a closed loop corrective action system. Corrective actions shall be implemented to reduce Level A defects or when the total of Level B process indicators exceeds 3%. Problems identified shall be escalated to plant management when corrective action has not produced the desired result within thirty (30) days. Continuous process improvement techniques shall be used to ensure continuing effort to reduce defect rates and variance. The process control system shall be documented and available for review.

5.4.20.4.1 Defect rates and variance. Each variance from the requirements of 4.19 and 5.4.21 shall be documented, prior to any rework or repair action, as either:

a. A soldering or assembly defect (Table XI Level A), or,

b. A process indicator (Table XI Level B).

Defect and process indicator rates shall be calculated in accordance with 5.4.20.4.2.

5.4.20.4.1.1 Reworkable defects. After inspection and documentation, reworkable defects shall be returned to the proper area for rework per paragraph 5.4.19.3, testing, if required, and reinspection.

5.4.20.4.1.2 Non-reworkable defects. Non-reworkable defects shall be dispositioned as non-conforming material in accordance with contractual requirements.

5.4.20.4.2 Defect rate and variance calculation. The defect rate (see 5.4.20.4.1) is the number of observed defects divided by the normalizing number. The assembly defect rate and solder defect rate shall be calculated and documented each time inspection, in accordance with 5.4.20.4 or 5.4.19.6, is performed. Assembly defect rates and solder defect rates are separately calculated as follows:

a. The assembly defect rate shall be calculated by dividing the assembly defects observed (including table XI defects) by the normalizing number. The normalizing number for assembly defects shall be the total of the number of components, component leads, terminals and wires contained on the assembly plus one for the printed wiring board.

b. The solder defect rate shall be calculated by dividing the solder defects observed (including table XI defects) by the normalizing number. The normalizing number for solder defects shall be the total number of terminals plus the total number of solder connections (for plated-through-hole printed wiring boards, the top and bottom connection is ONE integral connection) on the assembly. For calculating hand solder defect rates, only hand soldered connections shall be counted. For calculating machine solder defect rates, only machine soldered connections shall be counted. No connection shall be counted twice.

c. The assembly and solder defect rates shall be calculated and documented for each assembly. In addition, the summation of each defect rate shall be calculated and documented each working day for all assemblies inspected that day. Defect rate documentation and data shall be made available to the Government.

TABLE XI. Defects and process indicators.

Level A
Soldering Defects

No.	
A101	Nonsoldered connections
A102	Bridging
A103	Rosin connection
A104	Cold solder joint
A105	Fractured or disturbed
A106	Insufficient solder
A107	Excessive solder, lead not discernible
A108	Poor wetting
A109	Solder splattering
A110	Pits, pinholes, holes, or voids (where the bottom of the void, pit, or pinhole cannot be seen)
A111	(No defect for this code at this time)
A112	Dewetting of solder connection area(s)
A113	(No defect for this code at this time)
A114	Solder points, peaks, or icicles
A115	Flux residue, oils, greases on assembly
A116	Improper tinning of stranded wire
A117	Overheated solder
A118	Unfilled plated-through hole (when fill is required by drawing)
A119	Contaminants in solder connection
A120	Excess solder in bend radius
A121	All other solder defects except those listed as Level B process indicators

Level A
Assembly Defects

No.	
A130	Improper transmission of stress of leads and wires (improper stress relief)
A131	Metal-cased components mounted over circuit path (not insulated)
A132	Uninsulated wires or component leads routed over the circuit path where shorting is possible

TABLE XI. Defects and process indicators (continued).

A133	Charring, burning, or damage to insulation (affecting electrical operation)
A134	Birdcaged wire
A135	Cut or nicked leads or wires
A136	Leads or wires scraped, exposing metal or stretched
A137	Lead clinched beyond allowable limits (electrical clearance insufficient)
A138	Excessive lead length (electrical clearance insufficient)
A139	Insufficient lead length
A140	Excessive wicking
A141	Improper insulation clearance
A142	Excessive terminal fill

Level A
Assembly Defects

No.	
A143	Improper lead bend radius
A144	Improper lead bend clearance
A145	Unclinched components where clinching is required
A146	Component has improper clearance to adjacent components
A147	Component has improper clearance above the PWB
A148	Component not sufficiently supported
A149	Glass-cased components not protected by buffer material when epoxy conformal coating is used
A150	Component less than 1/16 inch (1.6 mm) to edge of PWB causing interference
A151	Component obscures termination or another component (unless design dictates otherwise)
A152	Physical damage of components
A153	Improper vertical mounted component clearance
A154	Improper terminal swaging
A155	Leads cut after final soldering
A156	Wrong parts used
A157	Wrong orientation of polarized components
A158	Component improperly spaced or located
A159	Damage to wire or strands
A160	All other assembly defects except those listed as Level B process indicators

Level A
Soldering, Assembly and Printed Wiring Boards Defects

No.	
	Soldering and Assembly Defects of Printed Wiring and Printed Wiring Boards
A180	Pattern delaminated (after soldering)
A181	Burned, scorched PWB or parts

TABLE XI. Defects and process indicators (continued).

A182	Excessive warp or twist (after soldering)
A183	(No defect for this code at this time)
A184	Delamination of base material
A185	Separation of conductor pattern
A186	All other printed wiring and printed wiring boards defects except those listed as Level B process indicators
	Printed Wiring and Printed Wiring Boards Defects (prior to soldering)
A190	Excessive warp or twist
A191	Laminate scratches which expose fiber
A192	Blisters in conductor pattern
A193	Wrinkles in conductor pattern
A194	Improper hole size
A195	Circuit defects which reduce cross sectional area by greater than 20%
A196	Improper solder coating
A197	Slivers on circuit
A198	All other printed wiring and printed wiring boards defects except those listed as Level B process indicators

Level B
Process Indicators

No.	
B201	Charring, burning or damage to insulation (not affecting electrical operation)
B202	Stranded wire lay disturbed (with no strand separation)
B203	Leads or wires scraped not exposing basis metal
B204	Insufficient or no lead clinch (non plated-through holes)
B205	Excessive lead length (electrical clearance sufficient)
B206	Improper lead wrap on terminals
B207	Component not resting on feet, pads or projections
B208	Component markings not legible with correct component installed
B209	Component not mounted perpendicularly
B210	Component less than 1/16 inch (1.6 mm) to edge of PWB not causing interference with mounting of PWA
B211	Possible component abrasion with another component
B212	Improper lead swaging
B213	Lack of solder coverage on lead ends (not due to cutting after soldering or handling)
B214	Excessive solder, lead is discernible
B215	Component not centered
B216	PWB pits, scratches or inclusions (that do not expose basis metal or fiber)
B217	Pits, pinholes, holes, or voids (bottom of the void visible and free of residues)
B218	Dewetting on PWB conductor paths (areas which are not part of a solder joint)
B219	Solder not smooth and shiny
B220	Unfilled plated-through hole
B221	Measling or crazing

5.4.21 Workmanship. In addition to the visual appearance of solder connections (see 4.19), the workmanship criteria shall be in accordance with 5.4.21.1 through 5.4.21.19.

NOTE: Paragraphs 5.4.21 through 5.4.21.15 are intended to be final assembly requirements. All printed wiring, however, should be inspected prior to processing to ensure the printed wiring to be incorporated into assemblies meets both the final assembly requirements of 4.19 and 5.4.21 through 5.4.21.15 below, and the printed wiring requirements of 4.5.

5.4.21.1 The conductive pattern on printed wiring or the exposed copper on solder masked printed wiring shall either be solder coated or coated with a tin-lead plating which has been reflowed. Reflowed tin-lead plating on printed wiring shall have a smooth, bright appearance and shall be fused to the base metal. Vertical edges of conductors need not be covered.

5.4.21.2 Conductors and termination areas shall not be cut, notched, etched, abraded, scored or otherwise reduced by more than 20 percent of the width or thickness. Cuts, scores and abrasions shall not be acceptable if basis metal is exposed.

5.4.21.3 Conductors and termination areas (including terminal pads) shall not be separated either partially or totally from the board surface.

5.4.21.4 Solder mask. Solder mask shall be continuous in all areas designated to be covered. There shall be no chipping or fracturing of solder mask nor shall there be separation of the solder mask from laminate or metallic foil. The solder mask shall not cover materials foreign to the laminate or foil. Adherence between solder mask and laminate and between solder mask and foil shall be complete for the total area. Transmissibility and opacity of the solder mask shall allow for inspection of underlying board characteristics. Permanent solder mask shall not tent empty plated-through holes. Temporary solder masking materials, if used, must be removed.

5.4.21.5 Printed wiring, boards, and assemblies shall be free of grease, silicones, flux residues, and other contaminants, including dirt, chips, solder spatter and splats (including solder balls), insulation residue, wire clippings, and both ionic and nonionic foreign matter.

5.4.21.6 The conductor pattern of rigid, rigid-flex, or flexible printed wiring assemblies nor the parts mounted thereon shall have no combination of edge roughness, nicks, pinholes, and scratches exposing basis metal which reduces the conductor width more than 20 percent of the minimum specified on the assembly drawing for each conductor width. There shall be no occurrence greater than 0.50 inch (12.7 mm) in a conductor length. The conductor pattern shall have no tears or cracks.

5.4.21.7 The weave of glass laminates shall not be exposed on either surface.

5.4.21.8 Except as specified in 5.3.23.1, platings for parts and all printed wiring, boards, and assemblies shall be complete and continuous with no separation from the base material.

5.4.21.9 Neither rigid, rigid-flex, or flexible printed wiring assemblies shall be blistered, haloed, or delaminated, nor shall the assemblies include any measling which exceeds a, b, or c, below. The printed wiring board assembly or flexible printed wiring assembly shall include no measled area which exceeds a, b, or c, below. For the purpose of this document, the term "measled area" means all measles, crazing or a combination thereof included within any given area.

a. All measling, crazing or combination thereof contained in a given measled area shall be totally enclosed within a superimposed square measuring 1/4 inch by 1/4 inch (6.4 x 6.4 mm) (see figure 107).

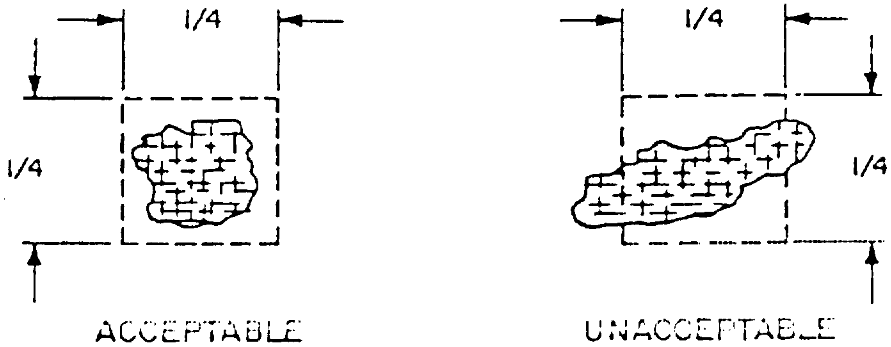


FIGURE 107. Maximum measled or crazed area (see 5.4.21.9a).

b. The sum of the measled areas, crazes or combination thereof, on both sides of the PWB shall not exceed three percent of the total area of one side of the board. Each measled area shall be the area enclosed by an imaginary line around all measles within 1/8 inch (3.2 mm) of each other (see figure 108). Measles less than 1/8 inch x 1/8 inch (3.2 x 3.2 mm) area shall be summed as being 1/8 inch x 1/8 inch (3.2 x 3.2 mm). The percentage of measled area shall be the sum of the measled areas on both sides of the printed wiring board, divided by the total area of one side of the printed wiring board multiplied by 100.

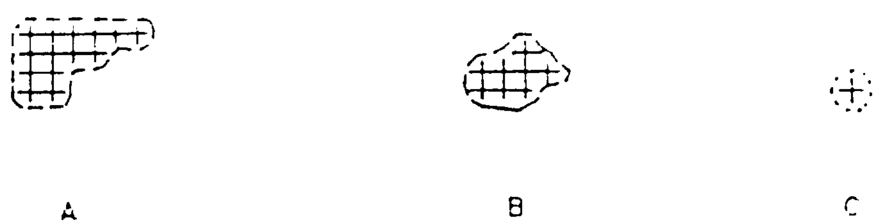


FIGURE 108. Examples of determining measled surface areas (see 5.4.21.9b).

c. When measled areas lie between conductors, the actual conductor spacing shall be reduced no more than 50 percent (see figure 109).

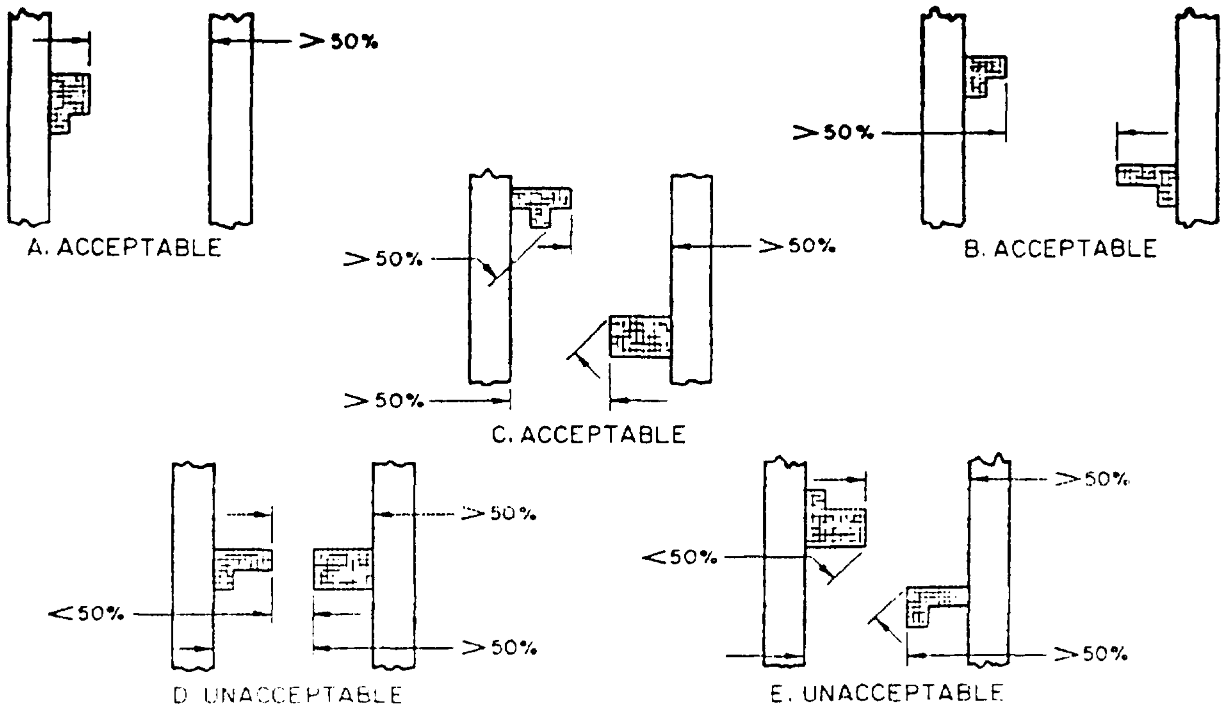


FIGURE 109. Measled areas between conductors (see 5.4.21.9c).

5.4.21.10 Terminals, wrapposts, and connector pins shall be approximately perpendicular with respect to headers, printed wiring boards, panels or chassis members unless tolerances are specified on applicable drawings. Terminals, wrapposts, and connector pins shall not be bent or otherwise deformed.

5.4.21.11 Plated-through holes used as via holes.

5.4.21.11.1 Hand soldered assemblies. Holes shall be left unsoldered.

5.4.21.11.2 Machine soldered assemblies. Holes may be either left unsoldered, or contain a solder plug that is not only continuous from one side of the printed wiring board to the other but also extends onto each terminal area. The solidified solder may be depressed on each or either side of the printed wiring board, but total depression shall not exceed 25 percent of the hole depth (d) (actual measurement not required except for referee purposes) as measured from the surface of the terminal area(s) (see figures 110A and 110B). When the unfilled hole option is used, the process must be designed to preclude the empty holes(s) being partially solder filled. Permanent solder mask shall not tent empty plated-through holes. Temporary solder masking materials, if used to prevent solder fill, must be removed from unfilled holes prior to final cleaning. Partially filled holes are not acceptable.

5.4.21.11.3 A plated-through hole used for lead or wire attachment shall be solder filled such that the solidified solder is not only continuous from one side of the printed wiring assembly to the other but also extends onto the terminal areas on each side of the printed wiring assembly (see figure 110C). Solder may be depressed on the component side of the lead attachment connection provided that wetting to both the lead and the terminal areas is acceptable. No depression of solder in a plated-through-hole with a part lead shall exceed 10 percent of the hole depth as measured from the surface of the terminal area (actual measurement not required except for referee purposes) (see figure 110D).

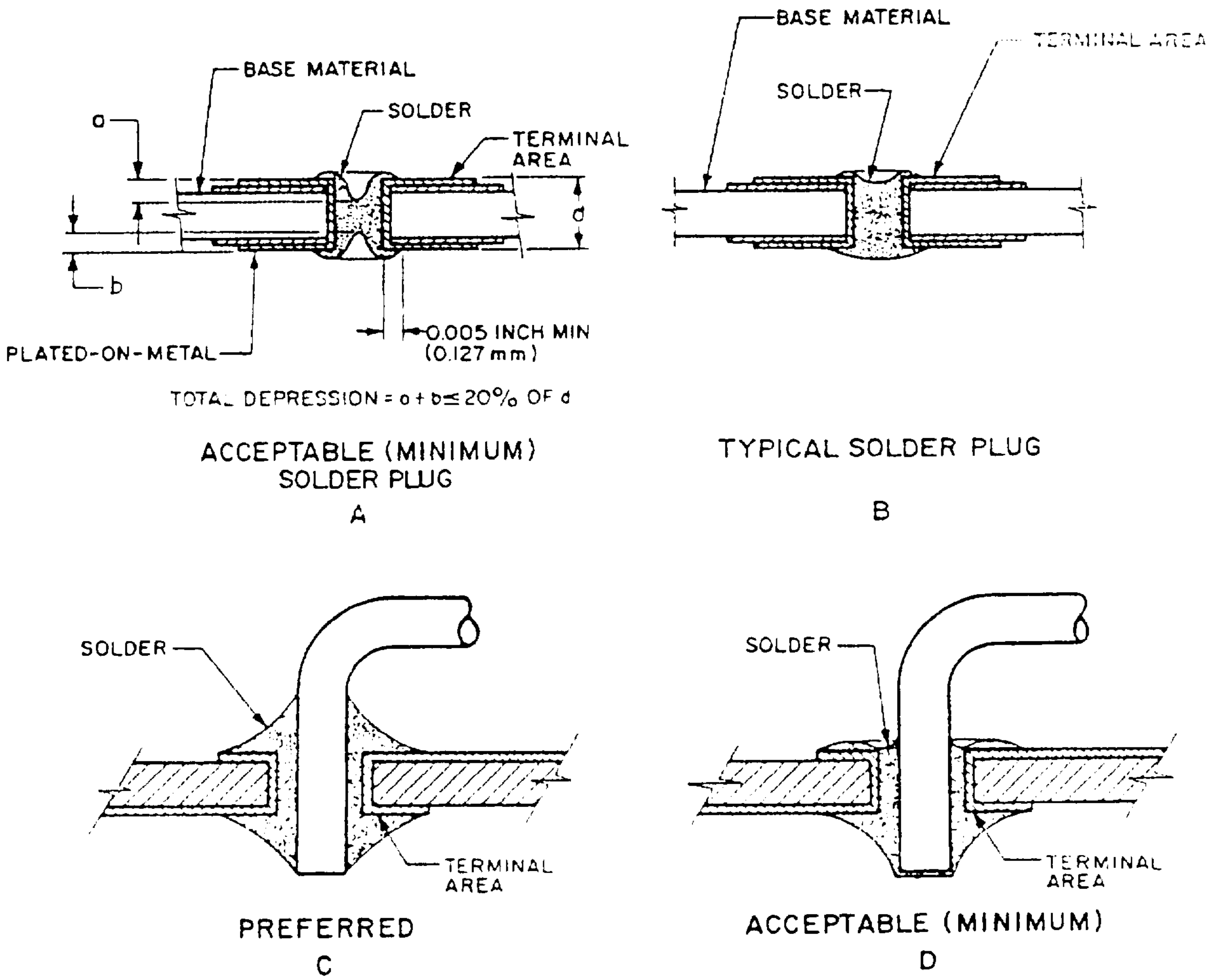


FIGURE 110. Plated-through hole interfacial and interlayer connections (see 5.4.21.11.2 and 5.4.21.11.3).

5.4.21.12 Insulation on wires and wiring shall be free of unspecified cuts and shall not be burned, charred, or abraded. Insulation shall not be pinched, shaved, cold flowed or otherwise reduced in thickness such that the insulation resistance or dielectric strength is degraded to a level less than specified for the insulation.

5.4.21.13 No wire or wires shall be routed in a manner which permits physical damage resulting from heat, sharp edges, or abrasion.

5.4.21.14 Wires or stands shall not be broken, birdcaged, severed, nor show evidence of nicks, cuts, scrapes, stretching, or other observable damage exceeding 5 percent of the wire diameter when viewed under 4X magnification. Discoloration of the wires or strands that shows evidence of overheating shall be cause for rejection.

5.4.21.15 Wicking under the insulation of stranded wire soldered to a terminal area is permissible provided that:

a. the insulation is of a type which can withstand soldering temperatures;

b. the length of wicking does not exceed 2 wire diameters or 1/8 inch (3.2 mm) whichever is greater;

c. the application does not require that the wicked portion of wire under the insulation be bent; and

d. the criteria for wicking is not otherwise specified for the particular application on applicable drawings.

5.4.21.16 Stress relief provisions for axial-leaded components. The leads of components mounted horizontally with bodies in direct contact with the printed wiring assembly shall be formed to assure that excess solder is not present in the formed bends of the component leads (figure 111). Solder may be present in the formed bends of axial-leaded components provided that it is a result of normal lead interface wetting actions and that the topside bend radius is discernible. Solder climb (wetting) on the lead shall not extend beyond the outer diameter of the surface PWB pads. Solder also shall not extend closer than 1 lead diameter from the component body.

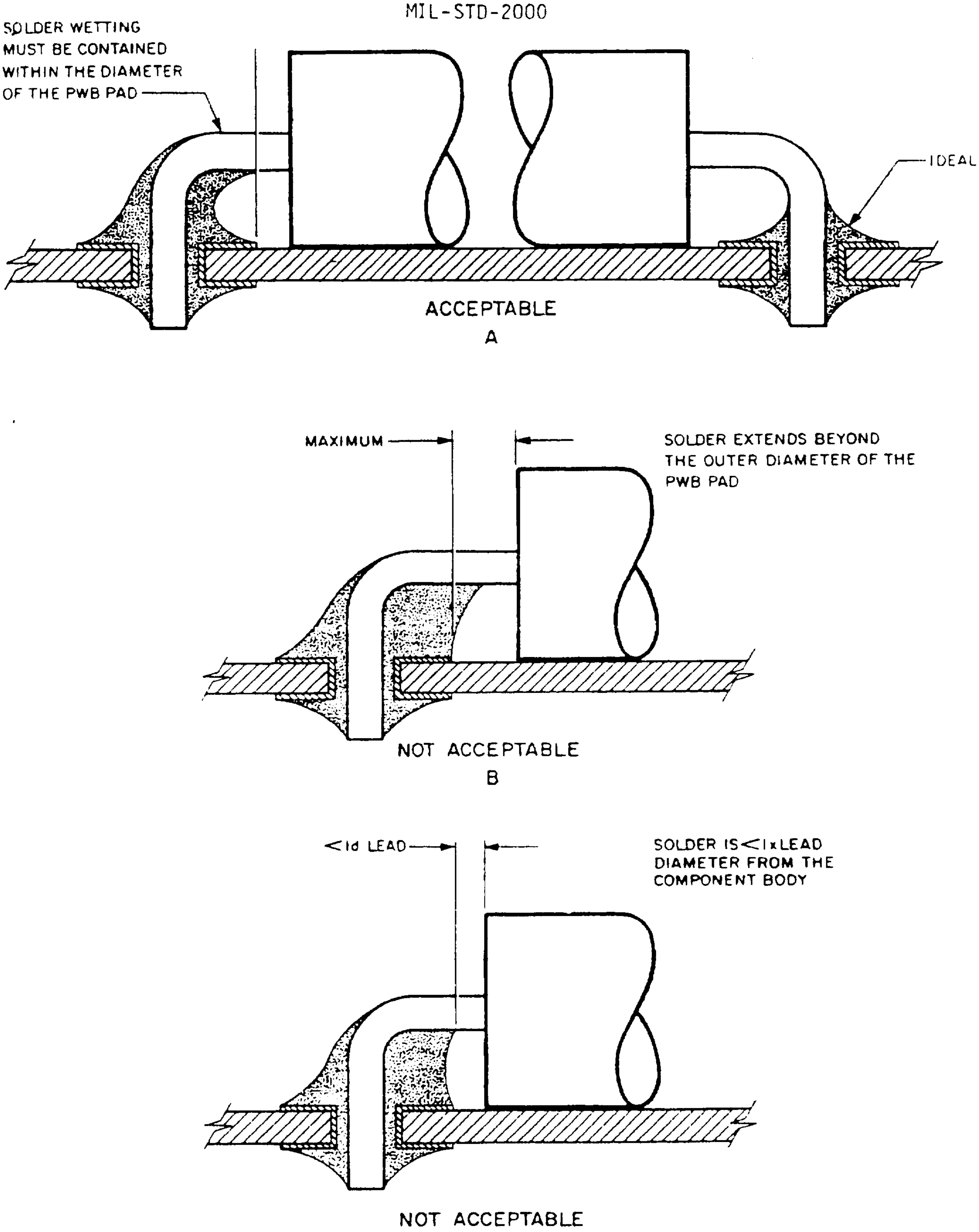


FIGURE 111. Solder in the lead bend radius (see 5.4.21.16).

5.4.21.17 Acceptance criteria for surface mounted components.

5.4.21.17.1 The body of the component shall not be cracked, scored, chipped, broken, or otherwise damaged.

5.4.21.17.2 There shall be no discernible discontinuities in the solder coverage of terminal areas of components of the reflow configuration. Solder shall not encase any nonmetallized portion of the body of a component of the reflow configuration.

5.4.21.17.3 The appearance of the solder joint surface shall be smooth, nonporous, and noncrystalline and shall have a finish which may vary from satin to bright. There shall be no discontinuities exceeding that permitted under 5.4.7.3 nor hairline fractures, cracks, or dewetting.

5.4.21.17.4 There shall be no visible evidence of contamination of the solder such as flux residue, grease, foreign material or discoloration.

5.4.21.17.5 Solder shall cover and blend smoothly to the complete substrate land or printed board terminal area and shall fillet to and blend smoothly with the metallized end cap as shown in figure 112A. It is preferred that solder cover the complete metallized area of the end cap as shown in figure 112B, but coverage to one half the thickness (T) of the component (including metallization) shall be acceptable provided there are no pits, voids or other discontinuity in the solder fillet.

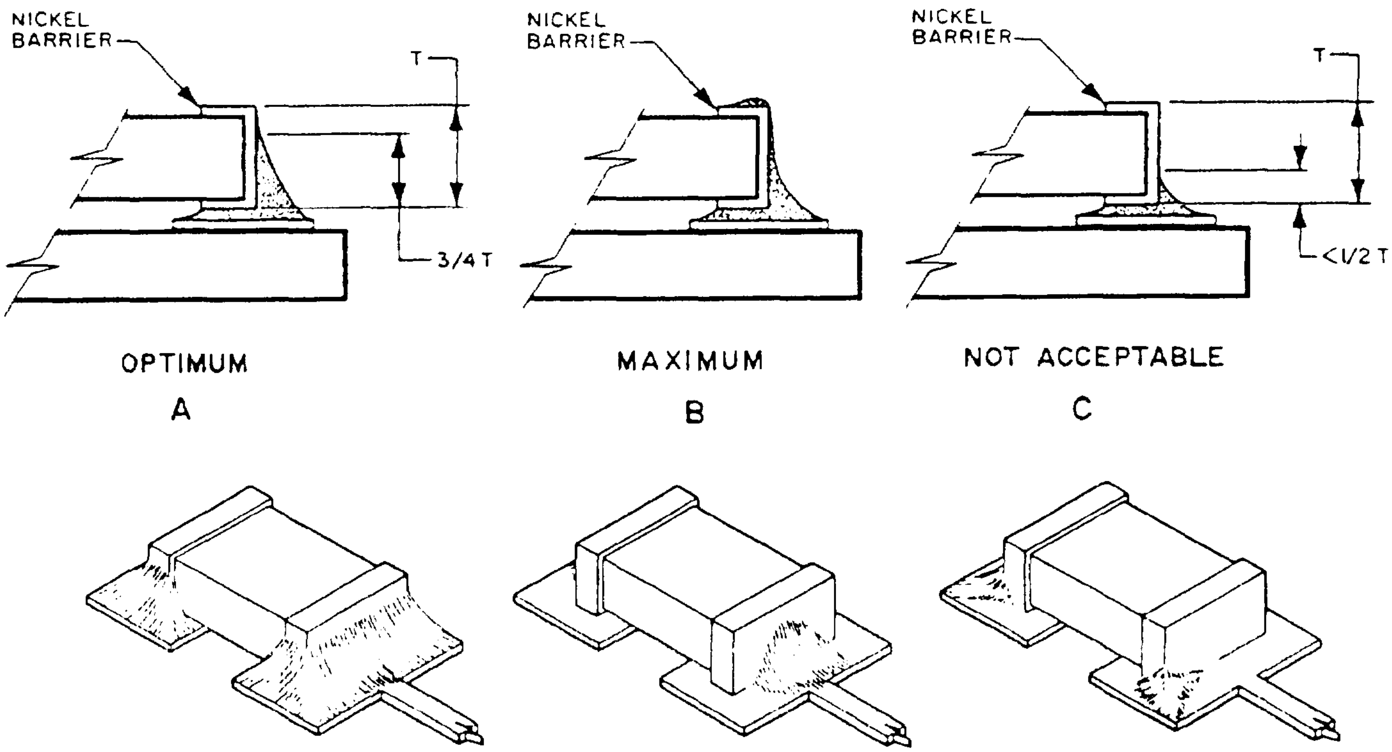


FIGURE 112. Solder filleting (see 5.4.21.17.5).

5.4.21.18 Conformal coating inspection. As an exception to 5.4.3, visual inspection without magnification for conformal coating acceptance is acceptable for the conformal coating defects listed herein. Inspection for conformal coating coverage may be performed under an ultraviolet (UV) light source when using conformal coating material containing a UV tracer. Magnification from 2X to 4X may be used for referee purposes.

5.4.21.19 Conformal coatings and encapsulants shall be of the type specified on the assembly drawing and shall:

a. Be completely cured, homogeneous, and transparent;

b. Cover only those areas specified on the assembly drawing;

c. Be free of voids or bubbles which expose component conductors, printed wiring (including ground planes) conductors, or other conductors;

d. Include no bubbles nor voids exceeding a diameter or width of 0.010 inch (0.25 mm) if adjacent to a component or component lead nor any bubble or void exceeding a diameter or width of 0.025 inch (0.64 mm) at any other location on the surface of the printed wiring assembly;

e. Include no clusters of bubbles in open areas of a printed wiring assembly, if any dimension of the cluster exceeds 1/4 inch (6.4 mm) or, if the cluster is adjacent to the body of a component, any dimension greater than 25 percent of the span of the side of the component to which it is adjacent, or 1/4 inch (6.4 mm), whichever is less;

f. Include no foreign particles, voids, bubbles, or clusters which bridge greater than 50 percent of the spacing between conductors. The remaining clearance must be greater than the minimum clearance spacing specified in MIL-STD-275;

g. Contain no visible blisters, cracks, crazes, measling, peeling, and wrinkles.

5.5 Task D: Hand Soldering Process Controls. Manual soldering shall be accomplished using the facilities, tools and materials specified in 4.9, 4.10, and if applicable, 5.4.9 through 5.4.15. Tools used in the soldering process shall be cleaned prior to use, be free of dirt, grease, flux, oil and other foreign matter, and shall be kept clean during use.

5.5.1 Preparation of the soldering iron. The soldering iron tip shall be fully inserted into the heating element casing, which shall be tightly attached to the handle. The soldering iron shall be heated and upon reaching a temperature which causes solder to melt, the tip shall be first tinned with a light coat of solder and then cleaned by wiping lightly on a clean, moist wiping pad (see 4.9.3.3). A thin, bright, tinned surface shall be maintained on the working surface of the tip to insure proper heat transfer to the connection being soldered. Oxidation scale shall not be allowed to accumulate on the tip or between the heating element and the tip.

5.5.2 Use of solder pots. Solder pots to be used for cleaning and tinning of areas to be soldered shall be temperature controlled, and unless otherwise specified, shall be set at a preselected temperature within the range of 500° to 525°F (260° to 270°C). Solder purity shall be controlled in accordance with 4.13.4.1 and 4.13.4.2. Total time in the solder of areas to be soldered shall not exceed 5 seconds per immersion cycle.

5.5.3 Use of thermal shunts. Thermal shunts (heat sinks) shall be used to protect heat sensitive components such as semiconductors, transistors, ceramic capacitors, crystal devices, and insulating materials from heat damage while soldering (see figure 113). Thermal shunts so utilized shall not damage the component being soldered.

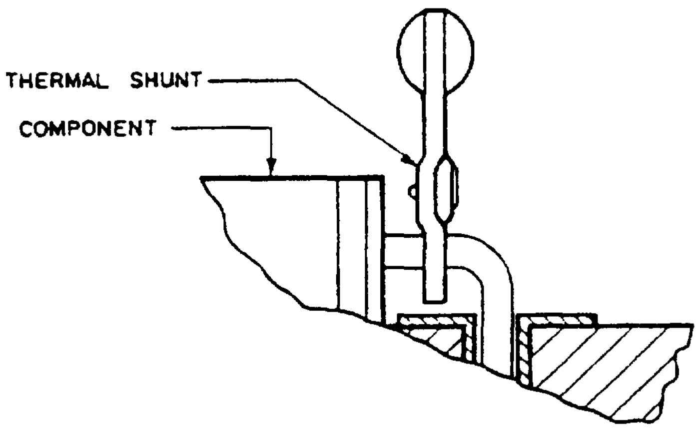


FIGURE 113. Thermal shunt (heat sink) (see 5.5.3).

5.5.4 Flux application. Flux in accordance with 4.10.2 shall be utilized for all soldered electrical connections. Liquid flux, when used, shall be applied in a thin, even coat and shall be limited to those surfaces to be joined prior to application of heat. The use of excess flux shall be avoided. When used, cored solder shall be placed in such a position that allows the flux to flow and cover the connection elements as the solder melts. When an external liquid flux is used in conjunction with flux cored solders, the flux shall be of the same manufacturer's type.

5.5.5 Heat application. The elements to be soldered shall be sufficiently heated to cause melting of the solder and wetting of the surface. Excessive heating time, pressure, and temperature shall be avoided to prevent unreliable joints or damage to parts, printed circuitry, insulation, or adjacent components.

5.5.6 Solder application. The area to be soldered shall first be properly heated and then the solder, in accordance with 4.10.1, shall be applied at the junction of the soldering iron tip and the parts or components being soldered (see figure 114). When soldering printed wiring assemblies with plated-through holes, solder shall only be flowed from the solder side of the printed wiring assembly. As an exception, the use of transfer soldering techniques shall be utilized in accordance with a documented process which is subject to review and disapproval. Precautions shall be taken to prevent any change in wire or lead positioning within the solder connection before the solder has completely solidified. The solder bridge for heat transfer shall be maintained throughout the soldering process. Wicking of solder underneath the insulation of stranded wire during the soldering operation shall be minimized through use of anti-wicking tools, heat sinks, or other appropriate methods and techniques. As a guide the soldering operation shall be completed within 2 to 5 seconds.

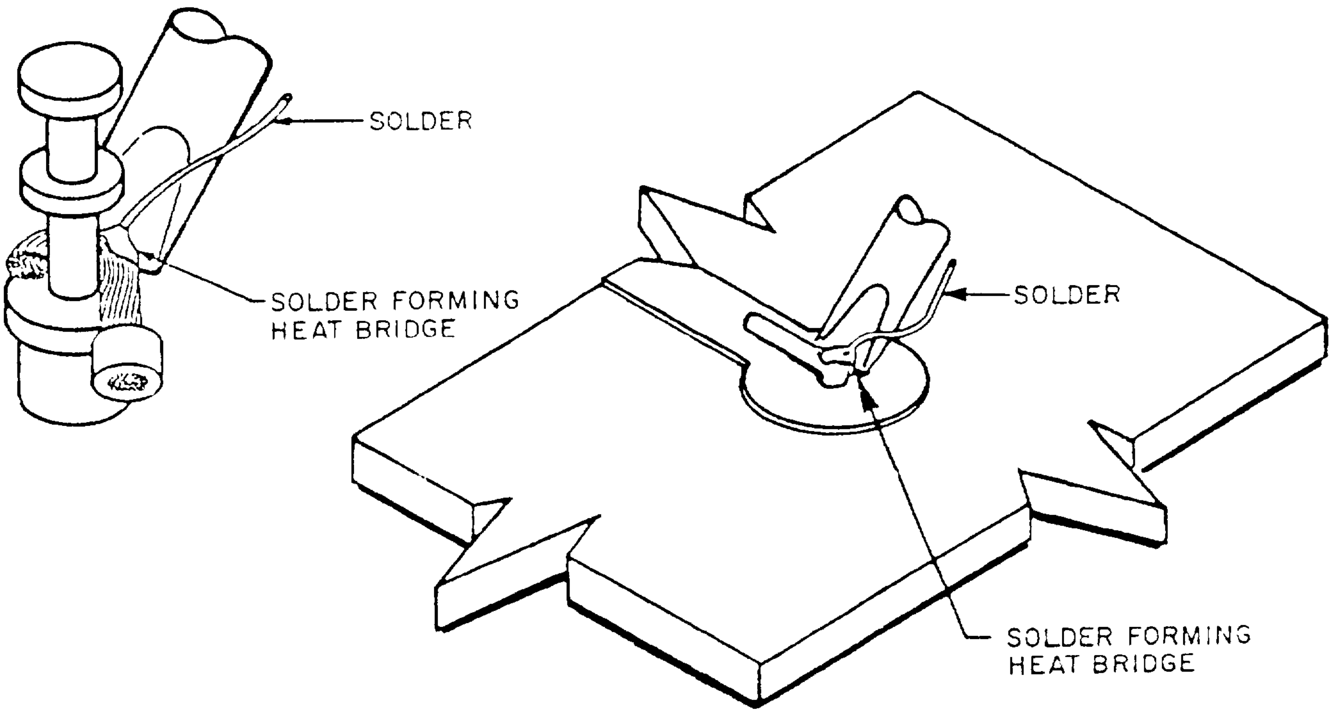
5.5.7 Cooling. The molten solder shall be cooled at room temperature. As an exception, controlled cooling may be used with documented processes which are subject to review and disapproval.

5.5.8 Cup and hollow cylindrical type terminals. Solder cup terminals shall be cleaned, pretinned and prefilled (see 5.4.17.2, if applicable) prior to insertion of the wire. Sufficient solder shall be used to fill the cup or receptacle when the wire is inserted. Sufficient heat shall be applied during filling of the cup to assure that all of the flux has risen and is not trapped at the cup bottom. No more than three (3) wires shall be installed in the cup, and in no instance shall the lay of the strands of any wire be disturbed, nor shall strands be removed to permit multiple wire insertion. After filling, the wire(s) shall be inserted straight into the cup cavity (see figure 117), touching the back of the inner wall of the cavity for the full length of the cavity and until it strikes the bottom. Continuous soldering iron control shall be maintained throughout the soldering operation.

The solder should rise slightly above the top of the cup and follow the contour of the cup entry slot. The contour of the wire shall not be obscured at the termination end of the insulation. Solder should not spill over and adhere to the sides of the terminal. Excess solder that spills over the terminal or from a weep hole shall be removed, such that the solder remaining on the outside of the solder cup is only in the form of a thin film.

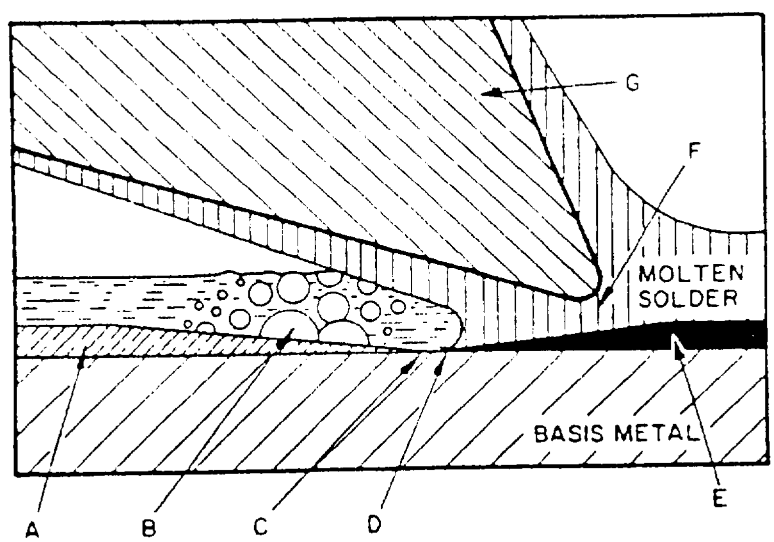
The prefilling and soldering of cup and hollow cylindrical terminals is illustrated in figures 115, 116, and 117.

NOTE: If the solder is fed too fast, a gas pocket may be formed or flux entrapped. This produces a false fill, since not enough solder is in the cup. This condition can be corrected by applying heat to the terminal base, reflowing the solder, and adding solder to fill the cup.



INITIAL BRIDGING BEING FORMED

A



A. FLUX SOLUTION LYING ABOVE OXIDIZED METAL SURFACE

B. BOILING FLUX SOLUTION REMOVING THE FILM OF OXIDE

C. BARE METAL IN CONTACT WITH FUSED FLUX.

D. LIQUID SOLDER REPLACING FUSED FLUX.

E. TIN REACTING WITH THE BASIS METAL TO FORM A NEW ALLOY.

F. SOLDER FORMING HEAT BRIDGE.

G. SOLDERING IRON TIP SHOWN NOT TOUCHING BASIS METAL FOR CLARITY.

B

FIGURE 114. Solder application and bridging (see 5.5.6).

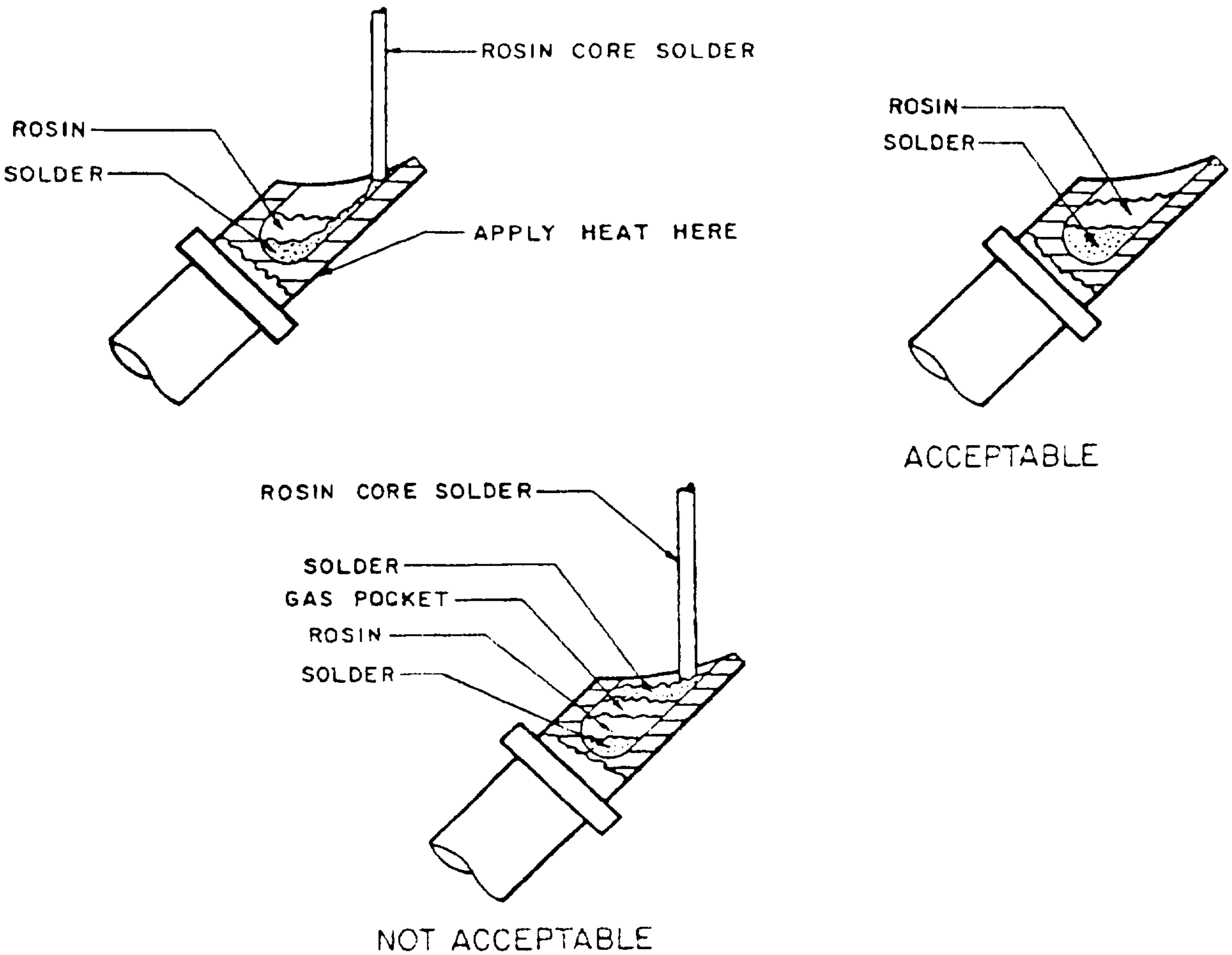


FIGURE 115. Prefilling hollow cylindrical terminals (see 5.5.8).

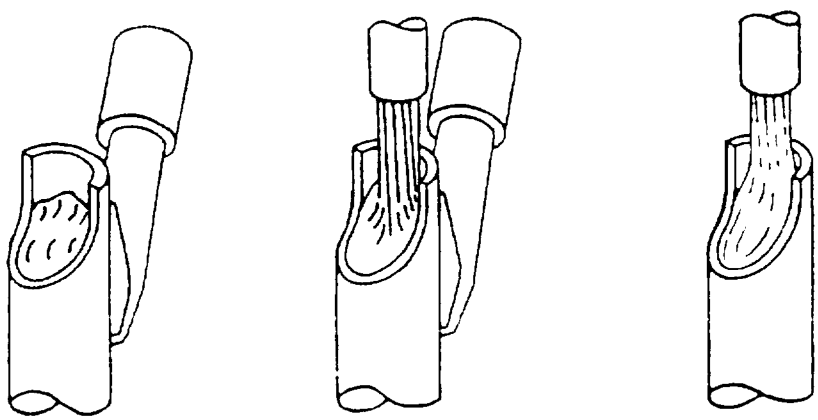


FIGURE 116. Soldering of hollow cylindrical connectors (see 5.5.8).

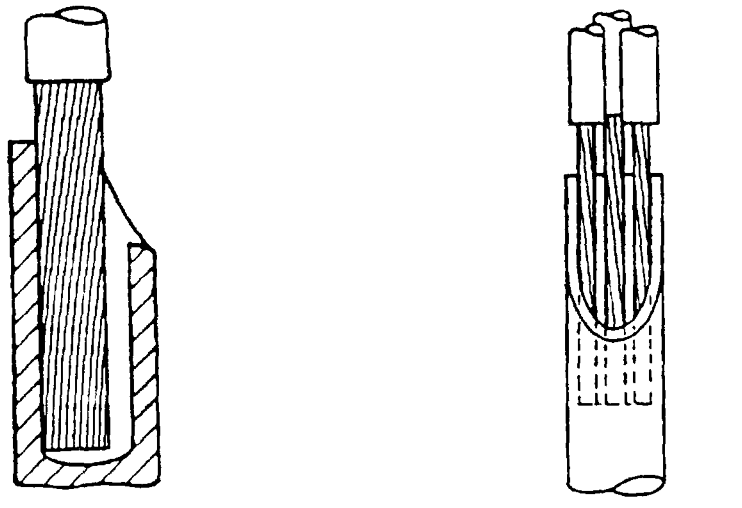


FIGURE 117. Cup type terminals (see 5.5.8).

5.5.9 Preparation of shielded wire.

5.5.9.1 Coaxial connectors. Coaxial connectors shall be assembled in accordance with detailed contractor work instructions prepared to reflect procedures recommended by the connector manufacturer except that, if solder or fluxes other than specified in 4.10.1, 4.10.2 and 4.10.3 are recommended for connector assembly, such solders or fluxes shall be documented on an approved assembly drawing.

5.5.9.2 Semirigid coaxial cable (hardline). Semirigid coaxial cable shall be assembled in accordance with detailed contractor work instructions that have been prepared to reflect the requirements documented on a government approved assembly drawing.

5.5.9.3 Braided shield terminations. Solder sleeves shall be installed in accordance with MIL-S-83519. Other braided shield terminations shall be in accordance with detailed contractor work instructions that have been prepared to reflect the requirements documented on a government approved assembly drawing.

5.5.10 Connection of conductors, component leads and terminals.

5.5.10.1 Insulation tubing applications. When required, insulation tubing which conforms to the applicable requirements shall be used and shall be installed as follows:

a. Tubing shall be placed over wires and leads prior to their attachment.

b. Tubing shall be held far enough from the connection so as not to interfere with or be damaged during the securing and soldering operations.

c. After the connection has cooled, been cleaned, and then inspected, the tubing shall be slipped over the connection and heat shrunk where applicable.

After installation, the tubing shall extend above the stripped portion of the attached conductor a distance equal to or greater than twice the shrunken tubing diameter.

5.5.10.2 Use of heat shrinkable soldering devices with shielded wires. Heat shrinkable soldering devices shall be installed in accordance with contractor work instructions which shall be available for review and disapproval. Terminations made with self-sealing devices shall be exempt from the cleaning requirements of this standard when the devices are made with material that encapsulates the solder connection.

5.5.11 Termination of magnet wires. For wire termination, the insulation shall be carefully stripped to a minimum of 1/2 inch (12.7 mm) and then tinned. Polyurethane coatings shall be stripped as specified in 5.4.6.1.4. When chemical strippers are used, the chemical residue shall be neutralized and the wire shall be cleaned. When used, the service lead wire insulation shall also be stripped a minimum of 1/2 inch (12.7 mm). Damage to the insulation and wire shall be limited to the amount allowed herein. The size of the service leads shall be governed by the magnet wire size as follows:

Magnet wire size (AWG)	Service lead size (AWG)
40-50 (ultra fine magnet wire)	Double service lead required. Magnet wire connected to 35-gauge wire which in turn is connected to 26 stranded service lead.
34-44	28-32 (stranded).
34	Connect the magnet wire directly to terminal.

5.5.11.1 Joining of magnet wire to service lead. The magnet wire shall be wrapped securely around the service lead a minimum of three turns, commencing 1/8 inch (3.18 mm) from the insulation. Any excess length shall be cut off.

5.5.11.2 Joining of magnet wire to magnet wire (winding-to-winding splice). The ends of the wires to be joined shall be placed parallel to each other, and twisted together a minimum of three turns.

5.5.11.3 Soldered splices for small diameter magnet wire. Small diameter magnet wire (AWG-34 gauge through 50 gauge) may be spliced to wires of larger diameter (service leads) which in turn can be attached to terminals (leading). When required by the design, splices may be made between the leads of individual windings. The requirements of 5.5.11.3.1, 5.5.11.3.2 and 5.5.11.3.3 are applicable only in the manufacture of transformers, inductors and coils.

5.5.11.3.1 Soldering of splice. The splice shall be soldered as specified in 5.5.6, taking care that the solder is applied not closer than 1/16 inch (1.58 mm) to the insulation. The solder shall be smooth with no sharp solder points.

5.5.11.3.2 Applying insulation. After cleaning and inspection, the spliced portion shall be bent back against the larger wire. The insulation shall be equivalent to or better than the original or specified insulation, and shall cover a minimum of 5/8 inch (15.88 mm) over the wire insulation.

5.5.11.3.3 Anchoring service lead. Unless otherwise specified on the applicable drawing, the service lead shall be taped or secured with non-reactive adhesive for a minimum length of 1/2 inch (12.7 mm) to the coil winding after application of the insulation.

5.6 Task E: Machine Soldering Process Controls. Machine soldering shall be accomplished using any integral system (see 4.12) which also incorporates:

a. Temperature controlled preheating and soldering stages (see 5.6.5.5 and 5.6.5.6);

b. An automatic fluxing stage (see 5.6.4.6);

c. A cooling stage (see 5.6.4.7); and

d. A speed controlled conveyor stage (see 5.6.5.3).

5.6.1 Wave soldering machines. In addition to 4.9.3.6 and 4.9.3.7, wave soldering machines shall have the capacity to preheat the assembly to within 120°C (216°F) of the solder temperature immediately prior to contact with the molten solder.

5.6.2 Other soldering systems. Drag soldering and other soldering equipment not specified herein shall be utilized in accordance with a documented process which is subject to review and disapproval.

5.6.3 Constraint of components. Components shall be constrained in a manner which precludes excessive motion during wave soldering.

5.6.4 General requirements.

5.6.4.1 Machine maintenance. Machines incident to the automated soldering process shall be maintained to assure capability and efficiency commensurate with design parameters established by the original equipment manufacturer.

5.6.4.2 Machine controls. The contractor shall have operating procedures describing the soldering process and the proper operation of the automatic soldering machine and associated equipment. For the soldering machine, these procedures, as a minimum, shall define the preheat temperature, solder temperature, rate of travel, frequency of temperature verification measurements and frequency of solder bath analysis. If any of the above mentioned characteristics must be adjusted for different printed wiring assemblies, the procedure shall identify by printed wiring assembly, drawing number, or other positive identification means, the setting to be utilized.

5.6.4.3 Holding fixtures and materials. Devices, materials or techniques used to retain parts and components to the printed wiring board through preheat, fluxing, soldering, and cooling stages shall not contaminate, mar, or otherwise damage or degrade printed wiring boards, parts, or components. The devices, materials or techniques shall not only be adequate to maintain component positioning but shall permit solder flow through plated-through holes and complete coverage of terminal areas on the component side of the printed wiring board. If used, skin packaging shall be vented to permit hole fill and terminal area coverage. Skin packaging shall not be utilized if it results in electrostatic discharge damage or degradation to components.

5.6.4.4 Carriers. Devices used for the transport of printed wiring assemblies through preheat, fluxing, soldering, or cooling stages shall be in accordance with 4.9.3.7.

5.6.4.5 Masking. Areas of printed wiring boards not to be soldered (including plated-through holes in which leads or wires are to be later inserted and soldered) shall be masked prior to the application of flux.

5.6.4.6 Fluxing. Flux shall be applied by the wave, foam or spray method which will produce an even coated bottom surface and hole fill. The solids content of the flux shall be maintained with a nonchlorinated solvent recommended by the flux manufacturer or with a government approved substitute.

5.6.4.7 Cooling (printed wiring). The printed wiring assembly shall be retained on the conveyor until the solder has solidified. The molten solder shall be cooled at room temperature. As an exception, controlled cooling may be used with documented processes which are subject to review and disapproval.

5.6.5 Wave soldering.

5.6.5.1 Solder bath. The solder bath shall be set to a preselected temperature between 480° and 520°F (249° and 271°C). The temperature measurement shall be made 1/16 to 1/8 inch (1.58 to 3.17 mm) (actual measurement is not required except for referee purposes) below the crest(s) of the molten solder wave(s) when no board is traversing the wave(s). The temperature and the time of contact between the printed wiring assembly and the solder shall be dependent upon such factors as preheating, thickness of board, number of contacts or conductors, and the type of parts. The period of exposure of any printed wiring assembly to a solder bath shall be limited to a duration which will not cause damage to the board or parts mounted thereon. The solder bath shall be periodically analyzed to insure that contamination levels do not exceed the limits specified in table V.

5.6.5.2 Maintenance of solder purity. To maintain the proper purity of solder, the following procedures shall be adhered to in machine soldering of printed wiring assemblies:

5.6.5.2.1 Before the start of soldering operations, dross shall be removed from the solder bath surface. Dross shall be periodically removed from the solder bath to assure that dross does not contact the items being soldered. Automatic or manual methods for removing dross are acceptable.

5.6.5.2.2 Solder in solder baths shall be chemically or spectrographically analyzed or renewed at the testing frequency levels shown in table V, column B. These intervals may be lengthened to the 8 hour operating days shown in column C when the results of analysis provide definite indications that such action will not adversely affect the purity of the solder bath. If contamination exceeds the limits of table V, intervals between analyses or replacement shall be shortened to those 8 hour operating days shown in column A, or less, until continued purity has been assured by analysis. Records containing the results of all analyses and solder bath usage shall be available for review by the government.

5.6.5.3 Conveying. Preloaded and precleaned printed wiring assemblies shall be transported through the fluxer and preheater to the solder bath and on through the cooling stage at a rate preselected to assure compliance with 5.6.2.6. The speed shall not vary more than 1 inch (25.4 mm) per minute.

5.6.5.4 Lead Trimming. Leads may be trimmed after soldering provided the cutters do not damage the component due to physical shock. When lead cutting is performed after flow soldering, one repass over the solder wave shall be made to cover ends and to reflow the solder terminations to correct disturbances caused by side loading (this reflow is not considered a rework). When the number of leads cut after soldering is small, manual touchup may be used to reflow the solder, including coverage of lead ends.

5.6.5.5 Preheating. The areas of the PWB to be soldered shall be preheated to 160 to 240°F (71 to 116°C) as measured on the component side. All subsequent temperature measurements shall be made at the selected point for each board type. A preheat schedule shall be prepared for each type of board (as identified by PWB assembly part number designations) to be soldered based upon thickness and density and shall include the proper heater settings for preheating the boards to the required temperature. The selected temperature from board-to-board (of the same type) as measured on test specimens, shall be maintained within 10°F (5.5°C) but not to exceed the specified limit. Printed wiring assemblies shall be preheated to a temperature compatible with the flux, conveyor speed, solder temperature, and time of board contact with the solder bath.

5.6.5.6 Solder application. Solder shall be applied to the printed wiring assembly through contact with a solder wave compatible with the type of soldering machine being used. The time of contact between any point of the printed wiring assembly and the solder should be 5 seconds or less. Process documentation shall be prepared when contact times greater than 5 seconds are required and the process shall be subject to review and disapproval. The time of contact shall be preselected, dependent upon preheating, thickness of the board, number of connections and conductors and the type of components. The temperature of the solder shall be measured at a point 1/16 to 1/8 inch (1.58 to 3.17 mm) (actual measurement not required except for referee purpose) below the crest(s) of the wave(s) in the path of the board and shall be the preselect temperature (T) +10°F (+5.5°C) (see 5.6.5.1). The height of the wave and depth of immersion shall be maintained to assure effective contact and solder pressure sufficient for hole fill and solder spread to terminal areas on the component side of the printed wiring assembly.

5.6.6 Planar (Reflow) soldering.

5.6.6.1 Surface preparation. Solder shall be deposited or plated on both metal surfaces to be joined prior to positioning the components in place. Except when performed by the original part manufacturer, tinning performed prior to lead forming may extend past the knee bend but not witnin 0.005 inch (0.13 mm) of the component body.

5.6.6.2 Flux and solder application. Prior to or during the soldering process, a uniform coating of liquid flux, solder cream, solder paste, or other forms of solder shall be applied to the joint area where the component leads are to be soldered. Preliminary soldering (i.e.,tack soldering) operations may not require flux application.

5.6.6.3 Heat application. The component terminations to be soldered shall be heated to the flow temperature of the solder. The application of heat shall be controlled during the soldering operation to prevent damage to the assembly (e.g., base material, adjacent connections, electrical components). The surfaces being soldered shall be restrained to preclude movement relative to the terminal area as solder is solidifying. Leads which are not seated in contact with the termination area shall not be deflected or forced into place during soldering such that residual stresses remain in the lead after soldering.

5.6.7 Condensation (Vapor Phase) soldering. The condensation (Vapor Phase) reflow soldering method is generally used for back planes and connector reflow soldering. Prior to using this method for component soldering, it must be determined that no damage will occur to the components. Documented data verifying this evaluation shall be subject to review and disapproval. The condensation reflow system shall be mechanized to provide for smooth transition of the work piece, control of temperature, level of vapors and dwell time. There shall be a smooth transition out of the vapors after completion of the soldering operation to prevent disturbed solder connections prior to solidification.

6. NOTES

6.1 Tailoring guidance. The requirements of paragraph 5.2 through 5.6 and their subparagraphs are most effective when used together as a unit:

a. The personnel training and certification requirements of paragraph 5.2 are intended for applications using all of the requirements of this section.

b. The process control requirements of paragraphs 5.4, 5.5, and 5.6 are most effective when used together.

c. Paragraphs 5.5 and 5.6 are least effective when specified without paragraph 5.4.

d. The design and assembly manufacturing requirements of paragraph 5.2 should be specified whenever paragraph 5.4 is specified. Without the support of paragraph 5.3, manufacturers will encounter significant difficulty in manufacturing high quality assemblies in a process control environment. In addition, the added inspection requirement provided by paragraph 5.4 can only be met if proper design and material selection practices (i.e. as specified in paragraph 5.3) are used.

The combined requirements of this section will produce quality, reliable assemblies appropriate for use in space flight, life-critical, and mission critical applications.

6.2 Supersession note. This standard replaces a series of documents for soldering. The series consists of DOD-STD-2000-1B Soldering Technology, High Quality/High Reliability, and NOTICE 1, dated 15 January 1987; DOD-STD-2000-2A Part and Component Mounting for High Quality/High Reliability Soldered Electrical and Electronic Assemblies, dated 20 November 1986; DOD-STD-2000-3A Criteria for High Quality/High Reliability Soldering Technology, dated 30 April 1987; and DOD-STD-2000-4A General Purpose Soldering Requirements for Electrical and Electronic Equipment, dated 1 October 1987. This standard is intended to supersede the documents listed below. The listed documents will remain in effect until they are cancelled by separate notice.

MIL-S-45743	Soldering, Manual Type, High Reliability, Electrical and Electronic Equipment
MIL-S-46844	Solder Bath Soldering of Printed Wiring Assemblies
MIL-S-46860	Soldering of Metallic Ribbon Lead Materials to Solder Coated Conductors, Process for Reflow
MIL-S-50826(AR)	Soft Soldered Electrical Connections for Special Weapons Items Including Other Related Electronic Devices
MIL-S-50827(AR)	Soft Soldered Electrical Connections for Conventional Weapons Items Including Other Related Electronic Devices
MIL-STD-252(CR)	Classification of Visual and Mechanical Defects for Equipment, Electronic, Wired and Other Devices
MIL-STD-1460(AR)	Soldering of Electrical Connections and Printed Wiring Assemblies, Procedures for
QWS-10.00B	Acceptance Criteria for Solder Connections and Wiring in Electronic Equipment

WS-4554	Wave Soldering of Printed Wiring Assemblies, Automatic Machine Type
WS-6536	Process Specification Procedures and Requirements for Preparation and Soldering of Electrical Connections
WS-14146	Preparation, Soldering and Inspection of Electrical Connections

6.3 Subject term (key word) listing.

Connector
Degreaser
Electronic components assembly
Flux, soldering
Insulation sleeving, electrical
Printed circuit board
Printed wiring, flexible
Printed wiring board
Solder
Soldering iron
Solvent, stoddard's
Wiring harness

6.4 Use of metric units. English units (inches, pounds, Fahrenheit) are the primary units used by the United States Industry for manufacturing electronic assemblies. In this document, measurements are provided in English units followed by the metric equivalent. The conversions from English to metric are made in accordance with FED-STD-376. The metric equivalents provided in this document are rounded to sensible values. Direct conversions which are mathematically correct but reflect unreasonable degrees of precision in metric units have been avoided (i.e., 5.002 mm is considered unreasonable; this should be rounded to 5.0 mm). In the event of conflict, the primary English measurement shall take precedence.

Custodian:
Air Force - 20
Army - MI
Navy - AS
NSA - NS

Preparing Activity:
Navy - AS
(Project No. SOLD-0031)

Review activities:
AF - 11, 15, 17, 19, 84, 99
Army - AR, CR, ER, MR
Navy - EC, OS
DLA - ES, DH

User activities:
Army - AV
Navy - MC
DLA - DH

APPENDIX A

STODDARD PETROLEUM DISTILLATE SOLVENT
(See 4.10.4 and 4.10.4.4)

10. SCOPE. This appendix specifies the requirements for a petroleum distillate, referred to commonly as "Stoddard solvent" which shall be capable (see 30.1) of meeting the requirements herein and those of ASTM D 235, Type I. The requirements of this appendix correspond to the requirements of NAVAIRSYSCOM Drawing 200AS311.

10.1 Classification. The material shall be classified in accordance with ASTM D 235, Type I.

20. APPLICABLE DOCUMENTS.

20.1 Government documents. The following document forms a part of this appendix to the extent specified herein.

SPECIFICATIONS

FEDERAL

TT-T-266	Thinner: Dope and Lacquer (Cellulose-Nitrate)

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Naval Publications and Forms Center (Attn: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

20.2 Other publications. The following documents form a part of this appendix to the extent specified herein.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 235	Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM E 168	Recommended Practices for General Techniques of Infrared Quantitative Analysis

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

30. DEFINITIONS.

30.1 Capable of. "Capable of" shall mean that the requirements shall be met; however, the supplier is not required to inspect to the requirements of the drawing. The purchaser, however, may inspect and if the material does not meet a specified requirement, it shall be cause for rejection.

30.2 Petroleum distillate. Petroleum distillate shall mean a hydrocarbon distilled from petroleum and not contaminated with oxygenated, halogenated or other functional solvents not found naturally in petroleum.

APPENDIX A

40. GENERAL REQUIREMENTS.

40.1 Tabulated requirements. See table A-I.

TABLE A-I. Tabulated requirements.

Constituent	Percent; Max. by Vol.
1. Compounds with olefinic or cyclo-olefinic unsaturation	5
2. Aromatic compounds with 8 or more carbon atoms except ethylbenzene	8
3. Total of aromatics and olefins	20
4. Oxygenated solvents	Negative test

50. TEST REQUIREMENTS.

50.1 FED Spec TT-T-266, para 4.3.12 for compliance with tabulated requirements (see table A-I).

50.2 Solvent must meet all requirements of ASTM D 235.

50.3 Infrared analysis (see ASTM E 168) for compliance with 30.2.

APPENDIX B

PROCEDURE FOR MEASURING 2mV POTENTIAL AT SOLDERING IRON TIP
(See 5.4.14)

10. SCOPE. This Appendix establishes the procedure for measuring 2 mv potential at the soldering iron tip.

20. APPLICABLE DOCUMENTS. Not applicable.

30. DEFINITIONS Not applicable.

40. GENERAL REQUIREMENTS.

40.1 Equipment requirements. Minimum use specifications are the principal parameters required to perform the measurement and are included to assist in the selection of alternative equipment which may be used at the discretion of the using laboratory. Voltmeters must bear evidence of end-date calibration.

TABLE B-I. Equipment requirements.

item	Minimum use specifications	Measurement equipment and devices (see 40.2)
TRMS voltmeter	Accuracy: ± 10% at 2 mV RMS Frequency range: 50-500 Hz Input impedance: 10 megohms	Hewlett-Packard model 3400A or Keithley model 132F
Cable	Type: shielded BNC (male) to alligator	Pomona Electronics model AL-B-BNC-36
Ground clip	Type: oscilloscope probe to alligator	Tektronix part numbers 175-0125-01 and 344-0046-00
Shim stock	Material: brass or copper Thickness: 0.008-0.020 inches Size: approximately 1.5 x 0.75 inches	
Solder	Type: rosin core	

40.2 The instruments used in this procedure and listed in table B-I were selected from those known to be available at Department of Defense facilities, and the listing by make or model number carries no implication of preference, recommendation or approval by the Department of Defense for other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in the procedure and may be used.

APPENDIX B

50. DETAIL REQUIREMENTS.

50.1 Preliminary operations.

50.1.1 Preparation of conduction plate.

50.1.1.1 Remove any dirt and corrosion from surface of shim stock. If sufficient solder pool is already present on shim stock, proceed to step 50.1.2

50.1.1.2 Using the soldering iron under test (UUT), bond a small pool of solder to the shim stock as shown in figure B-1.

NOTE: Heat shim stock to sufficient temperature to create a well-wetted bond between shim stock and solder.

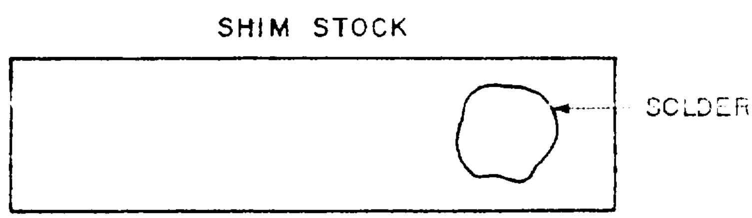


FIGURE B-1. Preparation of conduction plate.

50.1.2 Set-up of test equipment (see figure B-2).

50.1.2.1 Attach BNC cable connector to input of TRMS voltmeter (if Keithley model 132F is used, an additional banana (male) to BNC (female) adapter will be needed.

50.1.2.2 Attach ground clip probe clip to ground pin of UUT input plug.

50.1.2.3 Select appropriate range and/or function of TRMS voltmeter.

50.1.2.4 Plug TRMS voltmeter and UUT into the same duplex AC wall receptacle (Keithley model 132F is battery operated with no plug-in required).

50.1.2.5 Attach cable red wire alligator clip to conduction plate.

50.1.2.6 Attach cable black wire alligator clip to conduction plate.

50.1.2.7 Attach ground clip alligator to conduction plate.

50.2 Measuring process.

50.2.1 Measure test system RMS level.

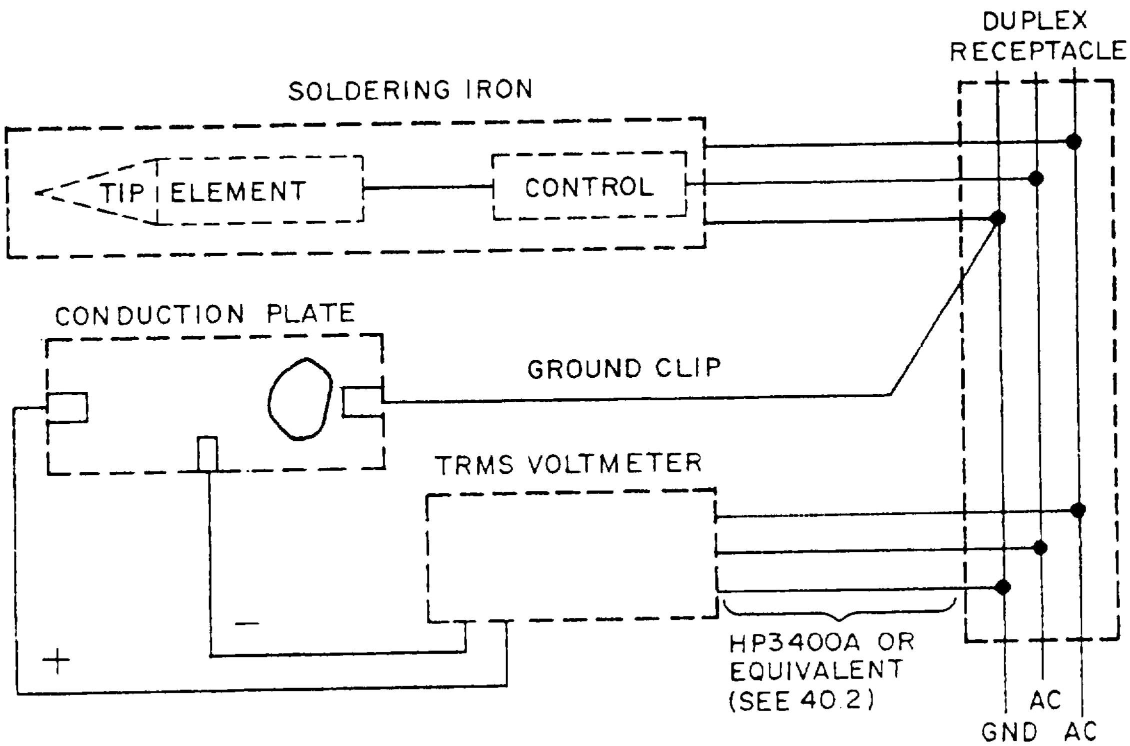


FIGURE B-2. Measurement of test system RMS level.

50.2.1.1 Turn on power to TRMS voltmeter and UUT. For temperature adjustable UUTs, set temperature control to maximum temperature. Allow 15 minutes warmup.

50.2.1.2 Record TRMS voltmeter value V1. This is the test system RMS level.

50.3 Measure UUT RMS level (see figure B-3).

50.3.1 Remove cable black wire alligator clip and ground clip alligator clip from conduction plate.

50.3.2 Attach cable black wire alligator clip to ground clip alligator clip.

50.3.3 Remove soldering element from holder and firmly press soldering tip against solder pool on conduction plate. Allow approximately 30 seconds for stabilization.

APPENDIX B

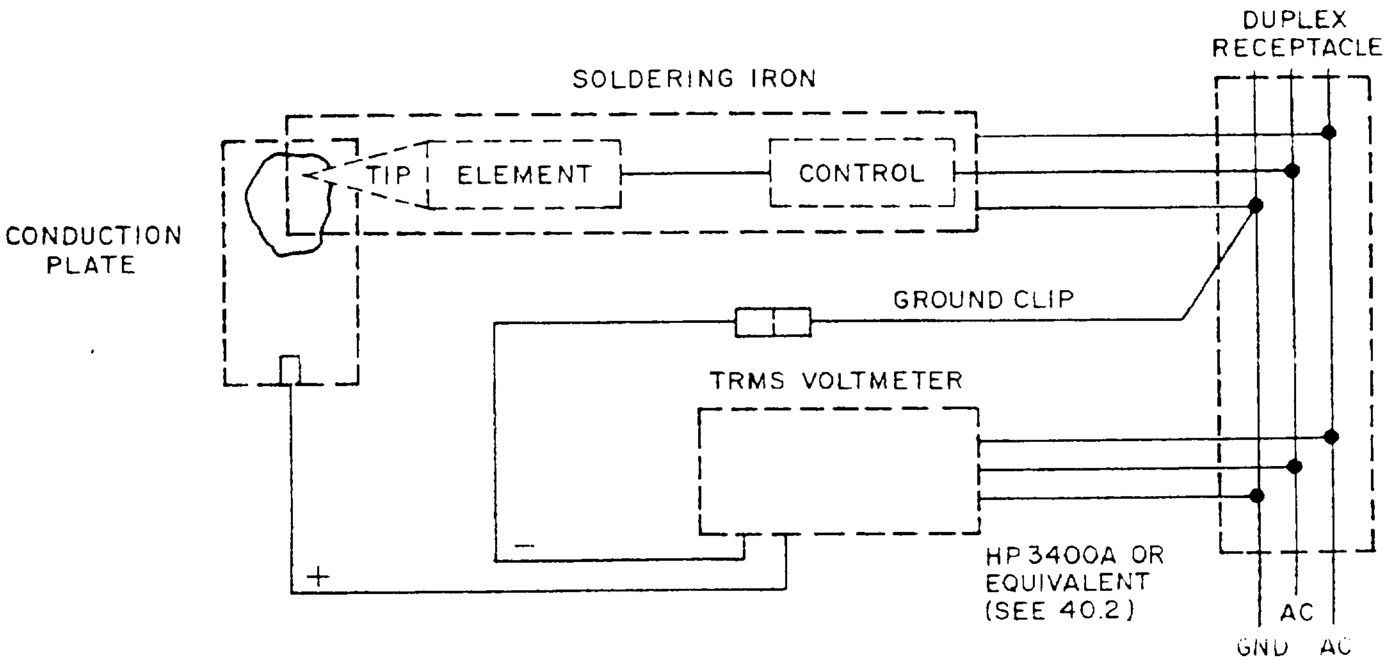


FIGURE B-3. Measurement of UUT RMS level.

50.3.4 Record TRMS voltmeter value V2.

50.3.5 Calculate and record UUT RMS level C1 such that C1 = V2 - V1.

50.4 Measurement report. A measurement report for each UUT shall be written and shall contain, as a minimum, the following information:

a. Description of UUT (Make, Model, Identification Number).

b. Test system RMS level V1.

c. RMS level V2.

d. UUT RMS level C1.

APPENDIX C

FOR INFORMATION ONLY

GOVERNMENT CERTIFICATION CATEGORIES

50. Certificate categories. Certificates may be issued in the following eight categories:

- A Government Senior Examiner
- B Government Instructor and Examiner (except category M)
- F Government Inspector (except category N)
- G Government Operator
- H Process Examiner
- M Government Contract Administration Office (GCAO) Instructor and Examiner
- N Government Contract Administration Office (GCAO) Quality Assurance Representative (QAR)
- R Restricted Operator or Inspector

50.1 Category A Government Senior examiner.

50.1.1 Category A Authority. Category A personnel are authorized to train, certify and require certification and recertification of personnel of all other categories. Category A personnel are also authorized to monitor and evaluate soldering processes, workmanship, training programs, and facilities for conformance to this standard.

50.2 Category B Government instructor and examiner (except category M).

50.2.1 Category B Authority. Category B personnel are authorized to require recertification of personnel of categories C, D, E, R, F, and G, to monitor contractor soldering processes and workmanship for conformance to this standard and to perform soldering operations and inspections at Government facilities for conformance with this standard.

50.4 Category F Government inspector (except category N).

50.4.1 Category F Authority. Category F personnel are authorized to perform inspections for conformance with this standard.

50.5 Category G Government operator.

50.5.1 Category G Authority. Category G personnel are authorized to perform operations in conformance with this standard.

50.6 Category H process examiner.

50.6.1 Category H personnel. Category H personnel shall be certified by the Government after satisfactory completion of an 80-hour soldering course, with primary emphasis on inspection and machine processes. Category H personnel certification and performance shall be reviewed on an annual basis.

APPENDIX C

50.6.2 Category H authority. Category H Government personnel are authorized to recommend recertification of category H contractor personnel and personnel of categories C, D, E and R, to inspect soldering processes and workmanship for conformance to this standard, to perform quality assurance actions, and to participate in materials review board (MRB) decisions.

50.6.8 Category R Restricted operator or inspector.

50.6.8.1 Category R Contractor personnel. Category R personnel shall be selected for performance of a limited number of operations or procedures. The training program shall, as a minimum, include the operations or procedures for which the category R personnel are to be certified. Functions or operations using a category R operator or inspector require prior approval of a Category A Government Senior Examiner.

50.6.9 Achievement of certified status. To be certified in category B or H, personnel shall attend and successfully complete an 80-hour formal training program at a Government approved school, as specified by the procuring activity. To be certified in categories F and G, personnel shall attend and successfully complete a 40-hour formal training program conducted by a category B instructor and examiner.

APPENDIX D

SELECTION AND EVALUATION OF MAGNIFICATION AIDS

1. Apparent-Field-of-View Angle: The angular subtense of the field of view in the image space of the optial system (the angle seen by the observer's eye) as differentiated from that in the object space (the real field).

2. Color Temperature: A measure of the energy distribution over the visible spectral range (i.e., the color quality) of a light source with a continuous spectrum expressed in Kelvins (K). The color temperature is the temperature on the absolute scale (degrees C + 273) to which a perfect blackbody radiator would have to be heated, which appears visually to be the same color as the light source in question.

3. Effective Color Temperature: A measure of the energy distribution over the visible spectral range of a light source using an approximation of an equivalent continuous spectrum resultant source expressed in Kelvins. The effective color temperature is the temperature on the absolute scale (degree C + 273) to which a perfect blackbody radiator would have to be heated to emit light with the closest visual color match to that of the approximation of the equivalent continuous spectrum resultant light source in question.

4. Effective Focal Length - of a magnification device: A measure of the distance from the principal point of the device's optical system to the corresponding focal point.

5. Fixed power single-eyed devices. Fixed power single-eyed devices, when used, shall have an eye-to-object distance not less than 2.25 inches (57.2 mm) and an object-to-lens working distance not less than 55 percent of the effective focal length of the magnifier.

6. Magnification power. The magnifying power (MP) for a visual magnification aid/device shall be determined with the device focused so its image appears at infinity and by using the equation:

$$MP = \frac{\text{Tangent beta } \beta}{\text{Tangent alpha } \alpha}$$

"Beta" β shall be one-half the angle subtended by the image (H') of an object (H) as seen through and centered in the field of view of the magnification aid/device.

"Alpha" α shall be one-half the angle subtended by the object (H) as seen at 10 inches by the unaided eye. Tangent "alpha" therefore equals 1/2 H measured in inches divided by 10.

The relationship between " β ", " α ", (H), and (H') is illustrated as follows:

APPENDIX D

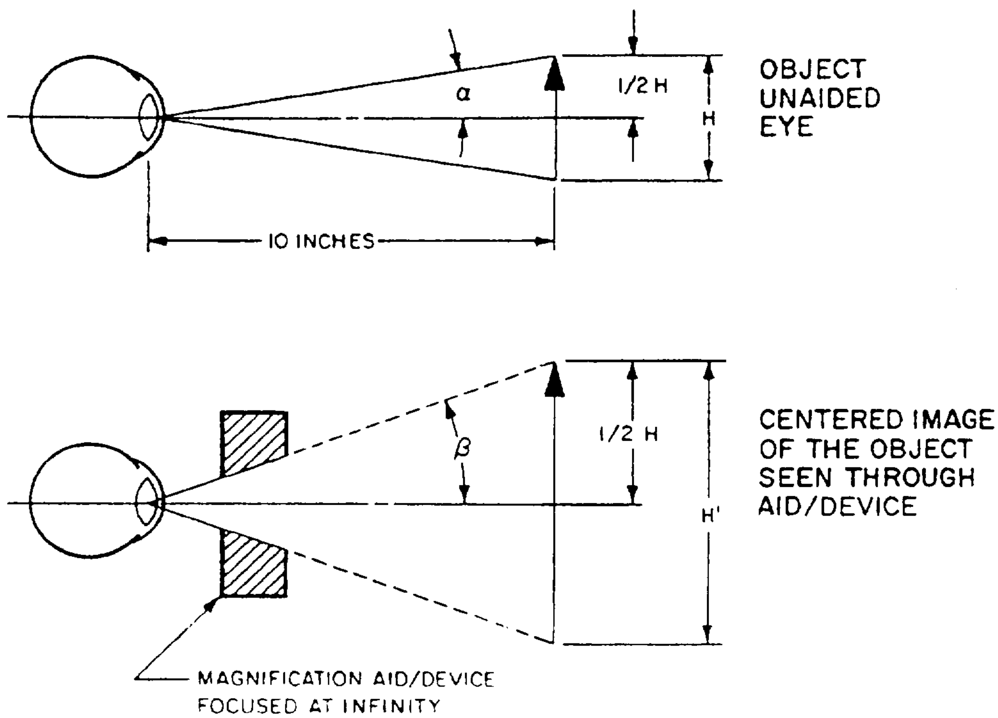


FIGURE D-1. Magnification power.

7. Percent of the Field of View - of a magnification device: The specific part of interest of the minimum required field of view of that device.

8. Proportional Dimensions - as viewed in magnification devices: The distortion of the optical system used in the magnification device shall be less than 3.0% over ±10 degrees apparent field of view.

9. Render True Color - in a magnification device: The color aberrations of the optical system shall be corrected enough to allow the magnifier to resolve the required details.

10. Resolution quality. As a definition of resolution quality, a viewer using the magnification aid should be able to discriminate at least 64 line pairs per millimeter (lp/mm) over ± 5 degrees apparent field of view and 45 lp/mm over ± 10 degrees apparent field of view from the center of the field at 10X magnification, or proportionally different resolution at others powers (i.e., 26 lp/mm over + 5 degrees and 18 lp/mm over + 10 degrees at 4X magnification.

APPENDIX D

11. Shadowless Illumination - for magnifying devices: The magnifying device's light source shall provide illumination on the area of interest from at least two directions at least 80 degrees apart so that no shadows fall on the area of interest from objects in the field of view that are not of prime interest.

12. System Effective Color Temperature: A measure of the energy distribution using an approximation of an equivalent continuous spectrum resultant source, expressed in Kelvins, of the transmitted visible spectral energy distribution range using the optical system's light source to illuminate the optical system's target area.

The system effective color temperature is the temperature on the absolute scale (degree C + 273) to which a perfect blackbody radiator would have to be heated to emit light with the closest visual color match to that of the approximation of the equivalent continuous spectrum resultant system transmission in question using the system's light source to illuminate the optical system's target area.

APPENDIX E

TASK/BASELINE REQUIREMENTS INTERRELATION

10. SCOPE. This appendix provides guidance to users attempting to interrelate the requirements of the baseline MIL-STD-2000 and the task requirements.

20. APPLICABLE DOCUMENTS. Not applicable.

30. DEFINITIONS. Not applicable.

40. GENERAL REQUIREMENTS.

40.1 Document organization. Paragraphs 4 and 5 of this document have been organized to be relatively consistent in their layout. Figure E-1 shows the parallelism of the requirements.

40.2 Impact of task implementation. The detail requirements of the tasks, when implemented by contract, supersede the baseline requirements in 4. Table E-I shows the direct impact of task implementation on the baseline requirements (i.e., all baseline requirements remain in effect unless directly superseded by the individual tasks).

TABLE E-I. Task/baseline interrelation.

Task	Paragraph	Baseline Paragraph	Impact
A	All	All	None. Task A required certification of personnel and has no superseding affect on the baseline requirements.
B	All	All	Varies. Except as cited below, the requirements of task B go above and beyond the requirements of the baseline. In addition, task B will have a superseding affect on many MIL-STD-275 requirements.
B	5.3.21 - 5.3.21.8	4.11.4.1	Both require 1/2 to 3/4 wire wrap. Task B has more detailed requirements and is used in lieu of 4.11.4.1.
B	5.3.19.6, 5.3.19.7.6	4.11.4.2	Little significant difference. Task B allows 1 diameter bend radius for all parts.
B	5.3.19.7.6	4.11.4.3	Both requirements apply; Task B supplements 4.11.4.3.
B	5.3.19.10.2	4.11.5.1	No difference.

APPENDIX E

TABLE E-I. Task/baseline interrelation (continued).

Task	Paragraph	Baseline Paragraph	Impact
B	5.3.19.10.1.2 - 5.3.19.10.1.6	4.11.5.2	Task B is more detailed and allows greater variety of mounting techniques.
B	5.3.19.10.3.3	4.11.5.3	No difference.
B	5.3.19.10.3	4.11.5.4	Task B requires greater contact area.
B	5.3.19.10.3	4.11.5.5	Task B does not allow side overhang.
B	5.3.19.10.3	4.11.5.6	No difference (no overhang allowed).
B	5.3.19.10.3.2	4.11.5.7	Minor difference.
B	5.3.19.10.3	4.11.5.8	Minor difference.
B	5.3.19.10.3.4	4.11.5.9	Minor difference.
B	5.3.19.8	4.11.6	Task B is significantly more detailed.
C	5.4.4	4.4	Task C provides more control and requires more testing.
C	5.4.9	4.9	Task C requires greater control over the solder facility.
C	5.4.14.1	4.9.3	Task C requires greater controls in soldering iron performance.
C	5.4.15	4.9.3.6	Task C requires greater controls in machine soldering system selection.
C	5.4.16	4.10.1	Task C requires phosphorus and sulphur contamination testing.
C	5.4.17.1	4.11.2	Task C prohibits broken strands.
C	5.4.17.6	4.11.3	In addition to 4.11.3, complete wetting and solder penetration to the inner strands is required.
C	5.4.19.8	None	Task C places requirements on the conformal coating process.

APPENDIX E

TABLE E-I. Task/baseline interrelation (continued).

Task	Paragraph	Baseline Paragraph	Impact
C	5.4.21	4.19	While most of the visual acceptance criteria is common, Task C requires evaluation of the printed wiring and solder mask. In addition, solder in the bend radius is limited. The solder coverage and fillet is described for surface mounted devices. Also, tighter limits are imposed on the insulation stripping process.
C	5.4.21.11	4.19.4	Plated-through holes that are used as via holes shall be left unsoldered during hand soldering operations and may be left unsoldered during machine operations. Complete terminal area coverage is required by task C (80% in 4.19.4). With a lead in the plated-through hole, solder depression is limited to 15% in Task C versus 25% in the baseline.
D	5.5.1	None	Proper iron preparation is required.
D	5.5.2	None	Solder pot operating temperatures and part immersion time limits are specified.
D	5.5.3	None	Thermal shunt use parameters are specified.
D	5.5.4	4.12.1	Task D requires common fluxes.
D	5.5.5	4.12.2	No significant differences.
D	5.5.6	4.12.3	Transfer soldering and wicking are limited in task D.
D	5.5.7	4.15	Task D allows controlled cooling with properly documented processes.
D	5.5.8	4.19.5.12	Additional process requirements are described for soldering cup terminals.
D	5.5.10	4.19.8	Use of manufacturer's work instructions is required by task D for installation of shield terminations.

APPENDIX E

TABLE E-I. Task/baseline interrelation (continued).

Task	Paragraph	Baseline Paragraph	Impact
E	5.6.1	4.9.3.6, 4.9.3.7	Additional requirements for preheater capacity are imposed on wave soldering machines.
E	5.6.4.1 - 5.6.4.4	None	Additional requirements are prescribed for the machine maintenance, control, and usage.
E	5.6.5.5	4.13.3	Task D imposes detailed preheat requirements.
E	5.6.5.1, 5.6.5.6	4.13.4	Task D requires tighter solder bath controls.

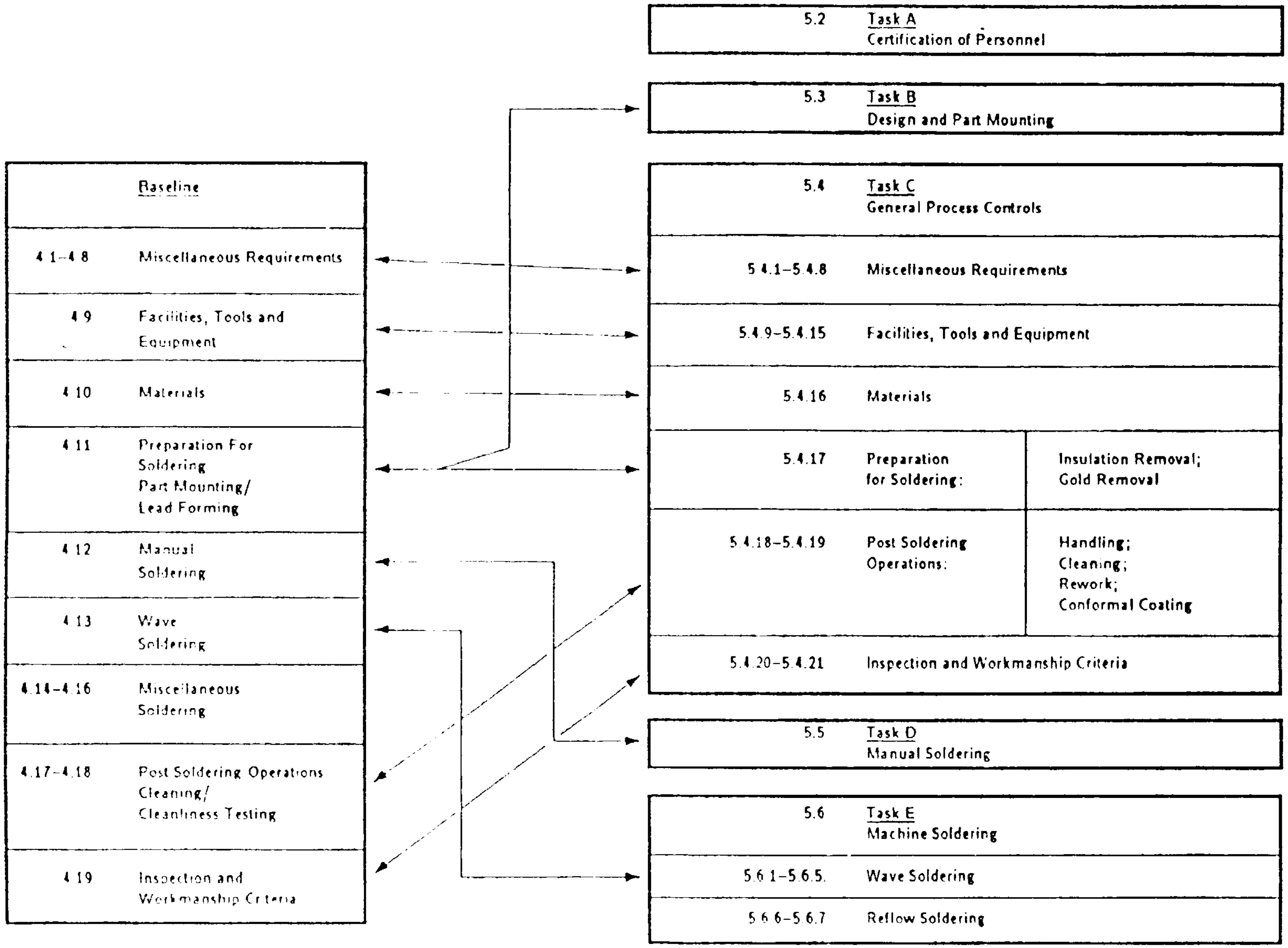


Figure E–1 Relationship between baseline and task paragraphs (see 40.1)

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX OF REFERENCED DOCUMENTS

INDEX OF REFERENCED DOCUMENTS (continued)

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